ENVIRONMENTAL PROTECTION AGENCY **6560-50-P**

40 CFR Part 192

[EPA-HQ-OAR-2012-0788; FRL-XXXX-X]

RIN 2060-AP43

Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings

AGENCY: Environmental Protection Agency (EPA).

ACTION: Proposed rule.

SUMMARY: The Environmental Protection Agency (EPA) is proposing to add new health and environmental protection standards to regulations promulgated under the Uranium Mill Tailings Radiation Control Act of 1978 ("UMTRCA" or "the Act"). The Act governs the extraction and management of byproduct material produced by uranium recovery. The proposed standards will regulate byproduct materials produced by uranium in-situ recovery (ISR), including both surface and subsurface standards, with a primary focus on groundwater protection, restoration and stability. ISR has a greater potential to directly affect groundwater than does conventional milling. Therefore, by explicitly addressing the most significant hazards represented by ISR activities,

these proposed standards are intended to address the shift toward ISR as the dominant form of uranium recovery that has occurred since the standards for uranium and thorium mill tailings were initially promulgated in 1983. The general standards proposed today, when final, will be implemented by the Nuclear Regulatory Commission (NRC). This action also proposes to amend a specific provision in the current Health and Environmental Standards for Uranium and Thorium Mill Tailings rule to address a ruling of the Tenth Circuit Court of Appeals, to update a cross-reference to another environmental standard, to correct certain technical errors that have been identified since promulgation and to amend the title of the rule itself.

DATES: Comments must be received on or before [insert date], 90 days after publication in the Federal Register.

ADDRESSES: Submit your comments, identified by Docket ID No. EPA-HQ-OAR-2012-0788, by one of the following methods:

- www.regulations.gov: Follow the on-line instructions for submitting comments.
- Email: a-and-r-docket@epa.gov
- Fax: 202-566-9744
- Mail: Air and Radiation Docket, Environmental Protection Agency, Mailcode: 2822T, 1200 Pennsylvania Ave., NW, Washington, DC 20460.

- Hand Delivery: EPA West Building, Room 3334, 1301 Constitution Ave., NW Washington, DC 20004. Such deliveries are only accepted during the Docket's normal hours of operation; special arrangements should be made for deliveries of boxed information.

Instructions: Direct your comments to Docket ID No. EPA- HQ-OAR-2012-0788. EPA's policy is that all comments received will be included in the public docket without change and may be made available online at www.regulations.gov, including any personal information provided, unless the comment includes information claimed to be Confidential Business Information (CBI) or other information whose disclosure is restricted by statute. Do not submit information that you consider to be CBI or otherwise protected through www.regulations.gov or e-mail. The www.regulations.gov website is an "anonymous access" system, which means EPA will not know your identity or contact information unless you provide it in the body of your comment. If you send an e-mail comment directly to EPA without going through www.regulations.gov, your e-mail address will be automatically captured and included as part of the comment that is placed in the public docket and made available on the Internet. If you submit an electronic comment, EPA recommends that you include your name and other contact information in the body of your comment and with any disk or CD-ROM you submit. If EPA cannot read your comment due to technical difficulties and cannot contact you for clarification, EPA may not be able to consider your comment. Electronic files should avoid the use of special characters, any form of encryption, and be free of any defects or viruses. For additional information about EPA's public docket visit the EPA Docket Center homepage at http://www.epa.gov/epahome/dockets.htm.

Docket: All documents in the docket are listed in the www.regulations.gov index. Although listed in the index, some information is not publicly available, *e.g.*, CBI or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, will be publicly available only in hard copy. Publicly available docket materials are available either electronically in www.regulations.gov or in hard copy at the Office of Air and Radiation Docket, EPA/DC, EPA West, Room 3334, 1301 Constitution Ave., NW, Washington, DC. The Public Reading Room is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Public Reading Room is (202) 566-1744, and the telephone number for the Air and Radiation Docket is (202) 566-1742.

FOR FURTHER INFORMATION CONTACT: Andrea Cherepy, Office of Radiation and Indoor Air, Radiation Protection Division, Mailcode 6608J, U.S. Environmental Protection Agency, 1200 Pennsylvania Ave., NW Washington, DC 20460; telephone number: 202-343-9317; fax number: 202-343-2304; email address: cherepy.andrea@epa.gov.

SUPPLEMENTARY INFORMATION:

Outline. The information in this preamble is organized as follows:

Produced by Uranium In-situ Recovery
2. Addition of new section on applicability - § 192.50 Applicability
3. Addition of new section containing definitions - § 192.51 Definitions and cross-references
4. Addition of new section detailing standards - § 192.52 Standards for application during processing operations and prior to the end of the closure period
5. Addition of new section discussing monitoring requirements - § 192.53 Monitoring Programs
6. Addition of new section discussing requirements for corrective actions - § 192.54 Corrective Action Programs
7. Addition of new section detailing the effective date of the new subpart - § 192.55 - Effective Date

B. Other proposed amendments
   1. Revision to Rule Title – Public Health, Safety and Environmental Protection Standards for Byproduct Material
   2. Revision to Subpart C - Implementation
   3. Revision to Subpart D – Standards for Management of Uranium Byproduct Materials Pursuant to Section 84 of the Atomic Energy Act of 1954, as Amended

IV. What is the rationale for today's proposal?
   A. How does today's proposal relate to existing 40 CFR part 192?
   B. What groundwater protection standards are we proposing for ISR facilities?
      1. Generally applicable groundwater standards
      2. Alternate concentration limits
   C. Adequate characterization of groundwater prior to uranium recovery
      1. Establishing restoration goals
   D. Excursions
   E. Post-restoration stability monitoring
      1. Thirty-year post-restoration monitoring period, with provisions for shortening or lengthening
      2. What other options did EPA consider for the post-restoration monitoring period?
         a. Required thirty-year post-restoration monitoring period
         b. Narrative standard with no fixed monitoring period
      3. How will groundwater stability be determined?
         a. What do we propose for determining stability?

I. General Information

A. Does this action apply to me?

The regulated categories and entities potentially affected by the proposed standards include:

Category	NAICS code[1]	Examples of regulated Entities
Industry:		
Uranium Ores Mining and/or Beneficiating	212291	Facilities that extract or concentrate uranium from any ore processed primarily for its source material content

Leaching of Uranium, Radium or Vanadium Ores	212291	Facilities that extract or concentrate uranium from any ore processed primarily for its source material content

[1] North American Industry Classification System.

This table is not intended to be exhaustive, but rather provides a guide for readers regarding entities likely to be affected by this proposed action.

B. What should I consider as I prepare my comments to EPA?

1. *Submitting CBI.* Do not submit CBI information to EPA through www.regulations.gov or e-mail. Clearly mark the part or all of the information that you claim to be CBI. For CBI information contained on a disk or CD ROM that you mail to EPA, mark the outside of the disk or CD ROM as CBI and then identify electronically within the disk or CD ROM the specific information that is claimed as CBI. In addition to one complete version of the comment that includes information claimed as CBI, a copy of the comment that does not contain the information claimed as CBI must be submitted for inclusion in the public docket. Information marked as CBI will not be disclosed except in accordance with procedures set forth in 40 CFR part 2.

2. *Tips for preparing your comments.* When submitting comments, remember to:

- Identify the rulemaking by docket number and other identifying information (subject heading, Federal

Register date and page number).

- Follow directions - The agency may ask you to respond to specific questions or organize comments by referencing a Code of Federal Regulations (CFR) part or section number.
- Explain why you agree or disagree, suggest alternatives, and substitute language for your requested changes.
- Describe any assumptions and provide any technical information and/or data that you used.
- If you estimate potential costs or burdens, explain how you arrived at your estimate in sufficient detail to allow for it to be reproduced.
- Provide specific examples to illustrate your concerns, and suggest alternatives.
- Explain your views as clearly as possible, avoiding the use of profanity or personal threats.

Make sure to submit your comments by the comment period deadline identified.

C. <u>When would a public hearing occur?</u>

If anyone contacts the EPA requesting to speak at a public hearing concerning this proposed rule by [INSERT 30 DAYS AFTER PUBLICATION IN THE

FEDERAL REGISTER], we will hold a public hearing on [insert date]. If you are interested in attending the public hearing, contact Mr. Anthony Nesky at (202) 343-9597 to verify that a hearing will be held. If a public hearing is held, it will be held in Denver, Colorado.

D. What documents are referenced in today's proposal?

We refer to a number of documents that provide supporting information for our uranium and thorium mill tailings standards. All documents relied upon by EPA in regulatory decision making may be found in our docket (EPA-HQ-OAR-2012-0788) accessible via http://www.regulations.gov/. Other documents, *e.g.*, statutes, regulations, and proposed rules, are readily available from public sources. The documents below are referenced most frequently in today's proposal.

Item No. (OAR-xxxx-xxxx-xxxx)

xxxx "Considerations Related to Post Closure Monitoring of Uranium In-Situ Leach/In-Situ Recovery (ISL/ISR) Sites," Environmental Protection Agency, 2013.

xxxx "Economic Analysis: Proposed Revisions to the Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings Rule (40 CFR part 192)," Environmental Protection Agency, 2012.

xxxx "Groundwater Modeling Studies at In Situ Leaching Facilities and Evaluation of Doses and Risks to Off-Site Receptors from Contaminated Groundwater," Environmental Protection Agency, 2012.

xxxx "Statistical Analysis of Groundwater Monitoring at RCRA Facilities – Unified Guidance Document," Environmental Protection Agency, 2009.

xxxx "Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining, Volume 1: Mining and Reclamation Background," Environmental Protection Agency, 2008.

E. Acronyms and Abbreviations

The following acronyms and abbreviations are used in this document:

ACL – alternate concentration limit
AEA – Atomic Energy Act
BID – Background information document
CAA – Clean Air Act
CWA – Clean Water Act
CBI – Confidential Business Information
CFR – Code of Federal Regulations
DOE – U.S. Department of Energy
EIA – economic impact analysis
EO – Executive Order
EPA – U.S. Environmental Protection Agency
FR – Federal Register
ISR – in-situ recovery, also known as in-situ leach (ISL) recovery
l - liter
MCLs – Maximum Contaminant Levels
mg – milligram
MOU – Memoranda of Understanding
N - nitrate
NRC – U.S. Nuclear Regulatory Commission

NTTAA - National Technology Transfer and Advancement Act
OMB - Office of Management and Budget
RAC - Radiation Advisory Committee
RCRA - Resource Conservation and Recovery Act
RFA - Regulatory Flexibility Act
SAB - Science Advisory Board
SDWA - Safe Drinking Water Act
UIC - underground injection control
U.S. - United States
USD - United States dollar
UMRA - Unfunded Mandates Reform Act of 1995
UMTRCA - Uranium Mill Tailings Radiation Control Act of 1978
U.S.C. - United States Code
USDW - underground source of drinking water
WL - Working Level

F. Definitions

The following terms are used in this document:

Terminology	Definition
Adjacent Aquifer	An aquifer or portion of an aquifer that shares a border or end point with the exempted aquifer or the exempted portion of an aquifer.
Alternate Concentration Limit (ACL)	Concentration limit approved by the regulatory agency after best practicable restoration activities have been completed, following the process prescribed in section 192.52(c)(1)(i)(C), for a groundwater constituent that has not been restored to its restoration goal.
Aquifer	A geological "formation," group of formations, or part of a formation that is capable of yielding a significant amount of water to a well or spring. See 40 CFR 144.3.
Aquitard	A confining bed that retards but does not prevent the flow of water to or from an adjacent aquifer.

Background	The condition of groundwater, including the radiological and non-radiological constituents, in the exempted aquifer, adjacent aquifers, and in both overlying and underlying aquifers, prior to the beginning of ISR operations. The background groundwater constituent concentrations in the production zone prior to the beginning of ISR operations is commonly referred to by the industry and regulatory bodies as the "baseline."
Beneficiation	The initial attempt at liberating and concentrating a valuable mineral from extracted ore. This is typically performed by employing various crushing, grinding, and froth flotation techniques.
Constituent	A detectable component within the groundwater.
Exceedance	An exceedance has occurred when, during post-restoration stability monitoring, a groundwater protection standard is exceeded at any point of compliance well.
Excursion	The movement of byproduct material fluids from an ISR production zone into surrounding groundwater. An excursion has occurred when, during operations, restoration or stability monitoring, any two upper control limit parameters (*e.g.*, chloride, conductivity, total alkalinity) exceed their respective upper control limits in any overlying, underlying, or perimeter monitoring well. Horizontal excursions refer to the lateral movement of the water, while vertical excursions indicate movement of water through aquitards above or below the exempted aquifer.
Excursion Monitoring Well	Wells located around the perimeter of the production zone (horizontal excursion wells) and in overlying and underlying aquifers (vertical excursion wells), which are used to detect any excursions from the production zone. Excursion monitoring wells can serve as the "point(s) of compliance" during all phases of ISR.

Exempted Aquifer	An "aquifer," or its portion, that meets the criteria in the definition of "underground source of drinking water" in 40 CFR 144.3, but which has been exempted according to the procedures in 40 CFR 144.7. See 40 CFR 144.3.
Extraction Well	Well used to extract uranium enriched solutions from the ore-bearing aquifer; also known as a "Production Well." Extraction and injection wells may be converted from one use to another.
Groundwater	Water below the land surface in a zone of saturation. See 40 CFR 144.3.
Injection Well	A well into which fluids are being injected. See 40 CFR 144.3.
In-Situ Recovery	A method of extraction by which uranium ores are leached underground by the introduction of a solvent solution, called a lixiviant, through injection wells drilled into the ore body. The process does not require the extraction of ore from the ground. The lixiviant is injected, passes through the ore body, and mobilizes the uranium, and the uranium-bearing solution is pumped to the surface from extraction wells. The pregnant leach solution is processed to extract the uranium.
Ion Exchange	A common water-softening method often found on a large scale at water purification plants that remove some organics and radium by adding calcium oxide or calcium hydroxide to increase the pH to a level where the metals will precipitate out.
Lixiviant	A liquid medium used to recover uranium from underground ore bodies. This liquid medium typically contains native groundwater and an added oxidant, such as oxygen and/or hydrogen peroxide, as well as sodium carbonate/bicarbonate or carbon dioxide. The lixiviant is injected through injection wells into the ore body to mobilize the uranium. The resulting solution is then pumped via extraction wells to the surface, where the uranium is recovered from it for further processing.

Maximum Constituent Concentration	The maximum permissible level of constituent in groundwater, as specified in 40 CFR 192, Table 1.
Maximum Contaminant Level (MCL)	The maximum permissible level of contaminant in water which is delivered to any user of a public water system. See 40 CFR 141.2.
Mobilization	Geochemical migration of constituents.
Monitoring Wells	Wells used to obtain water samples for the purpose of determining the amounts, types, and distribution of constituents in the groundwater. Wells are located in the production zone, around the perimeter of the production zone (horizontal excursion monitoring wells), and in overlying and underlying aquifers (vertical excursion monitoring wells).
Operational Phase	The time period during which uranium extraction by in-situ recovery occurs. Operations begin when injection of lixiviant starts; operations end when the operator permanently ceases injection of lixiviant.
Ore	The naturally occurring material from which a mineral or minerals of economic value can be extracted profitably or to satisfy social or political objectives.
Overlying Aquifer	An aquifer that is immediately vertically shallower than (*i.e.*, directly above) the production zone aquifer.
Oxidizing Environment	An environment in which oxygen is present.
Parameter	A characteristic, feature, or measureable factor that helps to define the groundwater conditions.
Point(s) of Compliance	Site specific location(s) where groundwater protection standards must be met. During all phases of ISR, excursion monitoring wells can serve as the points of compliance; during the restoration, stability and post-restoration phases, points of compliance may also include monitoring, injection and extraction wells in the production zone, as determined by the regulatory agency.

Point(s) of Exposure	Intersection of a vertical plane with the boundary of the exempted aquifer.
Post-Restoration Phase	The period after the groundwater protection standards have been met, as determined by the regulatory agency.
Precipitate	To separate a substance (such as uranium) out of a solution as a solid.
Preoperational Monitoring	Measurement of groundwater conditions in the production zone, and in the groundwater up and down gradient from the production zone, as well as in overlying and underlying aquifers.
Production Zone	The portion of the aquifer in which ISR activities occur. The production zone lies within the wellfield.
Reduced Environment	An environment lacking oxygen.
Regulatory Agency	The Nuclear Regulatory Commission (NRC) or an Agreement State.
Restoration (Act of)	The process of returning groundwater quality to preoperational conditions for the purpose of achieving restoration goal values for identified constituents.
Restoration Goal	A concentration limit for an identified constituent in groundwater after restoration has occurred. Value is derived from the most protective regulatory standards in 40 CFR 141.62, 141.66, 141.80, 143.3, 264.94, and 192, Table 1, and from preoperational background levels in the wellfield, whichever is higher.
Restoration Phase	The period immediately after uranium extraction ceases, during which restoration activities occur.
Site	The land or water area where any facility or activity is physically located or conducted, including adjacent land used in connection with the facility or activity. See 40 CFR 144.3.
Stability Phase	The period after the restoration phase when groundwater protection standards are met and monitored to test for stability.

Solubilize	To make a substance (such as uranium) soluble or more soluble, especially in water, by the addition of an agent (*i.e.*, lixiviant).
Underground Source of Drinking Water (USDW)	An aquifer or its portion: (a)(1) Which supplies any public water system; or (2) Which contains a sufficient quantity of groundwater to supply a public water system; and (i) Currently supplies drinking water for human consumption; or (ii) Contains fewer than 10,000 mg/l total dissolved solids; and (b) Which is not an exempted aquifer. See 40 CFR 144.3.
Underlying Aquifer	An aquifer that is immediately vertically deeper (*i.e.*, directly below) than the production zone aquifer.
Upper Control Limit (UCL)	Preoperational concentrations of indicator parameters (*e.g.*, chloride, conductivity, total alkalinity) in horizontal and vertical excursion monitoring wells, as determined by the regulatory agency and contained in the license.
Uranium Byproduct Material	Waste produced by the extraction or concentration of uranium from any ore processed primarily for its source material content. Ore bodies depleted by uranium ISR operations and which remain underground do not constitute "uranium byproduct material.”
Uranium Recovery Facility	A facility licensed to manage uranium byproduct materials during and following the processing of uranium ores. Common names for these facilities include, but are not limited to, the following: a conventional uranium mill, an in-situ recovery (or leach) facility, and a heap leach facility or pile.
Wellfield	The area of an ISR operation that encompasses the array of injection, extraction, and monitoring wells and interconnected piping employed in the uranium in-situ recovery process. The area of the wellfield exceeds that of the production zone.

II. Background Information

A. What is the scope of this action?

In 1983, EPA originally promulgated regulations at 40 CFR part 192, Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, in response to the statutory requirements of the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA). These standards have been amended several times, most recently in 1995, with the addition of standards to correct and prevent contamination of groundwater beneath and in the vicinity of inactive uranium processing sites.[1,2] Pursuant to UMTRCA, our standards are implemented by the Department of Energy (DOE) at inactive processing sites managing residual radioactive material and by the Nuclear Regulatory Commission (NRC) or NRC Agreement State at active sites managing byproduct material.[3,4]

Today's proposal is limited to the following changes. We are proposing to add an additional subpart within 40 CFR part 192 to explicitly address groundwater protection at

[1] See 42 U.S.C. § 7911(6) for the definition of a "processing site."
[2] See 60 FR 2854, January 11, 1995, and 58 FR 60340, November 15, 1993.
[3] Defined as "tailings or wastes produced by the extraction or concentration of uranium or thorium (source material) from any ore processed primarily for its source material content." AEA section 11e.(2), 42 U.S.C. 2014(e)(2).
[4] Under Section 274 of the AEA, the NRC may enter into an agreement with a State for discontinuance of the NRC's regulatory authority and State's assumption of regulatory authority over specified radioactive materials and activities. The NRC must review and find the State's regulatory program is adequate to protect public health and safety and compatible with the NRC's regulatory program before entering into the Section 274 agreement. The NRC continues oversight responsibilities of the Agreement State regulatory program through the Integrated Materials Performance Evaluation Program (IMPEP).

uranium ISR operations. We are also proposing to amend a certain provision within the existing 40 CFR part 192 to address a ruling of the Tenth Circuit Court of Appeals, delete reference to an outdated standard, correct minor technical errors, and amend the title of the rule. We request public comment only on these proposed standards and amendments. We are not requesting, and will not respond to, public comments on any other 40 CFR part 192 provisions since they are beyond the scope of today's proposal.

B. Uranium extraction

The major deposits of uranium ores in the United States are located in the Colorado Plateau, the Wyoming Basin, the Texas Coastal Plain, and Nebraska. Recovery and processing of these ores have historically occurred by one of three methods: (1) conventional mining and milling operations; (2) heap leach operations; and (3) in-situ recovery. Below we present a brief explanation of the various uranium recovery methods.

1. Conventional mining and milling

Conventional mining and milling is one of the primary recovery methods currently used to extract uranium from uranium-bearing ore in much of the world and formerly the typical means of obtaining uranium in the United States. "Remoteness from populated areas" and "isolation of contaminants from groundwater" are considerations in selecting mill locations under current siting criteria found in NRC regulations.[5] Only one conventional mill in the United States is currently operating; all others are in standby status,[6] in decommissioning (closure) or have already been decommissioned.

Conventional uranium mines are either open-pit operations, where large volumes of uranium bearing material are excavated, or underground mines, where the uranium-bearing ore is extracted via mined openings into the subsurface. The extracted ore is then moved to the milling operation where the uranium is extracted by chemical treatments of the ore. The ores are crushed mechanically and then leached at the milling site. In most cases, sulfuric acid is the leaching agent, but alkaline solutions can also be used to leach the uranium, generally extracting 90 to 95 percent of the uranium.

The mill then processes the uranium from solution by solvent extraction using organic chemicals, then further extracts, precipitates, and finally dries the recovered uranium to produce a uranium oxide material, called "yellowcake" because of its yellowish color.[7] Finally, the

[5] See 10 CFR part 40, Appendix A, Criterion 1.
[6] Standby means the period of time that a uranium recovery facility may not be accepting uranium byproduct material, but has not yet entered the closure period.
[7] The term "yellowcake" is still commonly used to refer to this material, although in addition to yellow, the uranium oxide material can also be black or grey in color.

yellowcake is packaged in special 55-gallon drums and transported to uranium conversion, enrichment and fuel fabrication facilities to produce fuel for use in nuclear power and research reactors. The recovery process produces both solid and liquid wastes (*i.e.*, uranium byproduct material, or "tailings"), which are transported from the extraction location to an on-site uranium byproduct material impoundment or pond.

Uranium byproduct materials/tailings deposited into an impoundment or "mill tailings pile" must be carefully monitored and controlled. This is because the mill tailings contain radioactive or heavy metal constituents, including thorium and radium. The radium decays to produce radon, which may then be released into the environment. Because radon is a radioactive gas that may be inhaled into the respiratory tract, exposure to radon and its daughter products contributes to an increased risk of lung cancer.[8] The presence of radon is of particular concern in confined areas (such as mines or homes),[9] but radon can also be a health risk in open spaces.[10]

2. Heap leach

Another method of uranium extraction that some facilities may use is known as heap leaching. This method is

[8] http://www.epa.gov/radon/beirvi.html
[9] http://www.epa.gov/radon/pdfs/citizensguide.pdf
[10] The regulation of operating mill tailings impoundments to limit radon emissions is covered at 40 CFR part 61, subpart W.

most often used in situations where the uranium ore is of low grade or the geology of the ore body is such that conventional mining and milling is not cost effective. Although no such facilities currently operate in the United States, the heap leach process has been used in the past for uranium recovery, and there are plans for at least one facility to open within the next few years.

With the heap leach process, small pieces of ore are placed in a large pile, or "heap," on an impervious pad of plastic, clay, concrete, or asphalt, with perforated pipes under the heap. An acidic solution is then applied through drips or sprinklers over the ore to dissolve the uranium it contains. The uranium-rich solution drains into the perforated pipes, where it is collected and transferred to an ion-exchange system. The heap is "rested," meaning that there is a temporary cessation of application of acidic solution to allow for oxidation of the ore before leaching resumes. The ion-exchange system extracts the uranium from the solution, which is later processed into yellowcake either at the site or at another uranium recovery facility. The yellowcake is packed in special 55-gallon drums to be transported to uranium conversion, enrichment and fuel fabrication facilities to produce fuel for use in nuclear power and research reactors.

3. In-situ recovery (ISR)

In-situ recovery (ISR), also referred to as in-situ leach (ISL) (we will use the term ISR throughout the preamble and proposed rule), is now the dominant method of uranium recovery in the United States and much of the world. The research and development projects and associated pilot projects began in the 1960s in Wyoming with limited field applications. Through the mid-1960s to the mid-1970s, interest in ISR methods increased, particularly in Texas and Wyoming, with 18 commercial and 9 pilot-scale operations in place by 1980. During the 1980s, production of uranium by ISR was limited, but by the mid-1990s, uranium production by ISR reached 90 percent of United States production. Commercial and pilot operations demonstrated ISR as a viable uranium recovery technique where site conditions (*e.g.*, geology and hydrology) are amenable to its use. This technology produces a better return on investment than conventional mining and milling since it does not involve excavation of large volumes of ore or disposal of large volumes of byproduct material. Therefore, the cost to produce uranium is lower. The trend in uranium production has shifted toward the ISR process. There are currently five operating ISR facilities in the United States; another 15 are in standby status or are undergoing licensing.

In-situ (*i.e.*, in-place) recovery is defined as the underground recovery by oxidation/solubilization of uranium from the ore body (host rock - typically sandstone) into the groundwater by using native groundwater into which has been added oxidizing and complexing chemicals. This solution is known as lixiviant. Lixiviant is pumped into the ore zone through a set of injection wells and removed through extraction wells, followed by recovery of uranium at the surface by processing of the extracted waters.

The ore bodies most amenable to ISR are known as "roll front" deposits, which are formed when uranium in the oxidized groundwater encountered an area of the host formation where chemically reducing conditions existed. These reducing conditions are strong enough to chemically reduce and precipitate the uranium as a less soluble form, thus forming the ore zone. As new oxidized uranium enters the front, it continues to be chemically reduced, precipitate and deposit in successive "rolls". The injection of a lixiviant essentially reverses the geochemical reactions that originally formed the uranium deposit. The oxidizing agents in the lixiviant create an oxidizing environment that solubilizes the uranium from the formation and allows it to enter into the groundwater. The uranium, along with other constituents present in the formation (*e.g.*, metals such as molybdenum, vanadium, selenium, and arsenic), are then collected from the ore zone by extraction wells that pump the solution to the surface. At the surface, the uranium is collected by a system of piping that feeds to a processing facility, where the uranium is recovered in ion exchange columns and either further processed on-site into yellowcake, or transported to another facility for drying and packaging. After processing, the extracted and processed waters are recharged with the lixiviant chemicals and pumped back down into the ore zone for reuse in extracting more uranium. The yellowcake is subsequently transported to uranium enrichment, conversion and fuel fabrication facilities to produce fuel for use in nuclear power and research reactors.

Two general types of lixiviant solutions can be used, loosely defined as "acidic" or "alkaline" systems. Acidic lixiviants were used early in the development of ISR in the United States, but site-specific conditions at the sites showed that acidic lixiviants were generally unsuitable.[11,12] In the United States, the geology and geochemistry of the majority of the uranium ore bodies favors the use of alkaline lixiviants such as bicarbonate/carbonate and oxygen. Other factors in the choice of the lixiviant are the uranium recovery efficiencies, operating costs, and the ability to achieve satisfactory groundwater restoration

[11] Acidic lixiviants react with carbonates (calcite and dolomite) contained in the host rock and precipitate calcium sulfate. The calcium sulfate clogs the well screens and process lines, significantly decreasing the efficiency of the leaching process.

[12] Mudd, G.M (2001). "Critical review of acid in situ leach uranium mining: 1. USA and Australia," Environmental Geology, 41:390-403).

after production ceases.

In order to control and contain the flow of groundwater within the production zone, an inward hydraulic gradient is established using the injection and extraction (also known as production) wells.[13] To create and maintain this gradient, more water is removed from the production zone than is injected (commonly referred to by industry as the "bleed rate"). The extracted liquid (groundwater mixed with lixiviant) goes through the recovery process to extract uranium. The processed water may be either recharged with lixiviant and reinjected to continue the recovery process or used to flush out the remaining lixiviant and mobilized uranium during the restoration process. Any waste water not reused may be injected into a deep well for disposal or be sent to an impoundment on site (often called an evaporation pond or a holding pond). The waste water generated during and after operations at an ISR facility, as well as all evaporation pond sludges derived from such waste waters, have been determined to be uranium byproduct material by the NRC, bringing them under the jurisdiction of UMTRCA.[14]

The wellfield of an ISR operation is configured to

[13] The gradient controls the direction of flow of water within a water-bearing formation. Used here, the purpose of a gradient is to contain water within the production zone so that it does not migrate beyond the wellfield.

[14] NRC (2000). "Recommendations on Ways to Improve the Efficiency of NRC Regulations at In Situ Leach Uranium Recovery Facilities." Staff Requirements - SECY-99-0013.

efficiently exploit the underlying uranium ore zone based on the subsurface data collected prior to construction. The wellfield typically consists of a series of closely spaced (on the order of many tens to at most a few hundred feet) arrays of injection wells (typically consisting of 4 to 6 injection wells) with an extraction well in the center of each array.[15] Each of these arrays is intended to work as a unit to control the flow of groundwater bearing the lixiviant so that the injected solution is captured by the extraction wells. The spacing of the injection and extraction wells is determined by the hydrologic properties of the ore zone, as evidenced by hydrologic testing during the exploration of the site, wellfield construction and monitoring well construction and operation.

During operations there is a risk of the lixiviant and/or mobilized constituents spreading beyond the capture zone of the wellfield, which poses a risk of groundwater contamination outside the facility. A series of monitoring wells are positioned around the production zone to detect increases in indicator parameters that would signal an excursion of the injection solution or mobilized constituents from an ISR wellfield into surrounding groundwater. The operator of the ISR facility typically

[15] See EPA (2013). "Considerations Related to Post Closure Monitoring of Uranium In-Situ Leach/In-Situ Recovery (ISL/ISR) Sites."

remediates any detected excursions by taking corrective actions such as ceasing injection and pumping water out of wells near the excursion. The detection and remediation of excursions is a major regulatory operational concern and needs to be carefully monitored by the operators and the regulatory agencies as part of the licensing conditions.

After the ore body has been depleted to uranium levels that are no longer economically valuable, the operator will cease injecting lixiviant and begin restoration of the ore zone aquifer (*i.e.*, wellfield(s)) to return conditions to their preoperational state to the extent practicable. Extracted water, typically treated through reverse osmosis and often in combination with added reducing agents, is injected into the ore zone to flush out the remaining lixiviant and to attempt to restore the geochemistry of the ore zone to its original baseline condition. Other procedures also may be used to bring about chemically reducing conditions in an attempt to immobilize the uranium (along with any other mobilized metals) remaining within the ore zone.

Once the groundwater at the site has been restored and sufficient time has passed such that owner/operators can demonstrate that chemical conditions are stable, the injection and extraction wells are properly plugged and abandoned;[16] the wellfield infrastructure (pipes, header houses, etc.) is removed and surface operations equipment (impoundment liners, buildings, etc.) is dismantled and shipped offsite for appropriate disposal. The site is officially decommissioned when the radioactive materials license is terminated by the regulatory agency (*i.e.*, NRC or NRC Agreement State[17]). Because no long-term disposal facilities remain at decommissioned ISR sites, there is no perpetual care and monitoring as occurs with conventional mill tailings sites.

C. What is the statutory authority for the proposed amendments?

EPA is proposing these new standards and amendments under its authority in Section 275 of the Atomic Energy Act (AEA) of 1954, as amended by Section 206 of the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978.[18]

Section 206 of UMTRCA authorizes EPA to promulgate general standards for the protection of public health, safety, and the environment from radiological and non-radiological hazards associated with (a) residual radioactive materials located at specifically listed inactive uranium mill tailings sites and depository sites for such materials selected by the Secretary of Energy (commonly referred to as Title I sites;) and (b) the

[16] See 40 CFR 146.10, "Plugging and Abandoning Class I, II, III, IV, and V Wells."

[17]

[18] See U.S.C. 2022.

processing and the possession, transfer, and disposal of byproduct material at sites at which ores are processed primarily for their uranium and thorium source material content[19] or which are used for the disposal of such byproduct material (commonly known as Title II sites). See 42 U.S.C. 2022.[20] These health, safety and environmental standards are contained in 40 CFR part 192 and are implemented by the NRC and its Agreement States, and the DOE.

Title I of the Act covers inactive uranium mill tailings sites and depository sites. EPA was directed to set general standards that were consistent with the requirements of the Solid Waste Disposal Act (later amended as the Resource Conservation and Recovery Act, or RCRA) to the maximum extent practicable.

Title II of the Act covers operating uranium processing or disposal sites licensed by the NRC or Agreement States in or after 1978. EPA was directed to promulgate generally applicable standards to protect public health, safety, and the environment from hazards associated with processing, possession, transfer and disposal of byproduct material. Such standards were to address both radiological and non-

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[19] "Source material" is defined as "(1) Uranium or thorium or any combination of uranium or thorium in any chemical or physical form; or (2) Ores that contain, by weight, one-twentieth of one percent (0.05 percent), or more, of uranium or thorium, or any combination of uranium or thorium." See 42 U.S.C. 2014(z), 10 CFR 20.1003.

[20] Although the statute covers both uranium and thorium mill tailings sites, there are no existing thorium mill tailings sites.

radiological hazards; further, standards applicable to non-radiological hazards were to be consistent with the standards required under Subtitle C of the Solid Waste Disposal Act (*i.e.*, RCRA).[21] NRC was required to implement these standards at Title II sites. See 42 U.S.C. 2022(b), (d).

D. What are the existing requirements under 40 CFR part 192?

Requirements for inactive sites are addressed under subparts A, B, and C of 40 CFR part 192. Since today's proposals do not impact Title I sites, they will not be discussed further in this section.

The requirements currently applicable to ISR sites can be found in subpart D of 40 CFR part 192 (hereafter "subpart D"). Subpart D contains provisions for managing uranium byproduct materials during and following the processing of uranium ores, and to restoration of disposal sites following any such use of those sites. For purposes of today's proposal, provisions related to groundwater protection are of most interest. To fulfill the statutory mandate described in section II.C of this preamble, we derived these provisions from the RCRA groundwater monitoring framework applicable to hazardous waste disposal sites.[22] Today's

[21] With the restriction that EPA not require any RCRA permit for the processing, possession, transfer, or disposal of byproduct material.
[22] 40 CFR part 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities." See particularly subpart F, "Releases from Solid Waste Management Units."

proposal adapts this framework to the situation presented by the ISR technology. Though standards at subpart D apply to ISR facilities, ISR was not the predominant uranium extraction method at the time the standards were promulgated. Subpart D addresses contamination of aquifers resulting from releases of contaminants from uranium mill tailings impoundments, which are surface structures (engineered units) designed to contain uranium byproduct material (*e.g.*, conventional tailings impoundments, evaporation or holding ponds). The RCRA hazardous waste framework, which is intended to prevent, detect, and mitigate contamination of groundwater resulting from releases of hazardous waste being held in an engineered unit, is directly applicable to this situation.[23] A basic RCRA hazardous waste management unit is an engineered unit, designed, constructed, and installed to prevent any migration of wastes out of the unit to the adjacent subsurface soil, groundwater or surface water at any time during the active life (including the closure period) of the unit.

At ISR sites, however, the groundwater has already been influenced by the natural mineralization associated with the uranium roll front deposits. In essence, the "management

[23] The design and construction requirements for surface impoundments are also taken from 40 CFR part 264. See subpart K, "Surface Impoundments," specifically 40 CFR 264.221.

unit" that is the potential source of contamination is the natural setting itself, though extraction of the uranium from the deposit alters the geochemistry of the ore-bearing formation and may increase the concentrations of radionuclides and other metals in the water. Restoration activities attempt to restore the original geochemistry to the formation. However, at present, monitoring to verify restoration generally lasts for only a period of a few years at most.

Today we are proposing to establish standards that will require owners and operators to ensure that actions taken to restore the geochemical conditions in the groundwater persist through time, thereby limiting the future potential for groundwater to be degraded from undetected, long-term changes in groundwater from ISR operations.

E. Why does EPA believe new standards are necessary?

We believe that ISR-specific standards are necessary because these operations are sufficiently different from conventional mills and the existing standards do not adequately address their unique aspects.

In particular, we believe it is necessary to take a longer view of groundwater protection than has been typical of ISR practices. The Agency has at times found it difficult to assign an economic value to groundwater resources, and we have found this to be the case in the ISR context. Although the presence of significant uranium deposits typically diminishes groundwater quality, we are not confident that current industry practices for restoration and monitoring of the affected aquifer are adequate to prevent either the further degradation of water quality or the more widespread contamination of groundwater that is more suitable for human consumption.

Because monitoring after restoration is typically conducted for only a short period, we find it difficult to characterize the probability or magnitude of the costs involved in remediating such future contamination. Such costs are not now borne by ISR owners/operators, nor is there any guarantee that they could be held responsible if contamination were detected by new monitoring implemented years or even decades after the end of site activities. It is likely, however, that the costs of such remediation would exceed the costs of the more extensive monitoring (in all phases of site activity) that we are proposing today. In this sense, perhaps a generalized cost of groundwater remediation can be viewed as a proxy for the value of groundwater and its protection. Similarly, because ISR activities often take place in areas that are sparsely populated, and contamination may take years to reach groundwater being consumed by humans, it is difficult to characterize the benefits of our proposal by applying typical Agency metrics, such as the number of cancers averted.

Taking a more qualitative view of the situation leads us more broadly to consider the impacts on future groundwater uses. In many areas of the country, particularly in western states where ISR activities are most likely to take place, groundwater is a scarce and valuable resource that is being rapidly depleted to support increased demands. There is evidence that communities are making efforts to utilize groundwater that is not of "good" quality, and in our view this trend will only increase.

Thus, the Agency believes that it is in the national interest to preserve the quality of groundwater resources to the extent practicable, and that the best way to do so is to prevent contamination by addressing its source.[24] We believe today's proposal, which focuses on the source of potential contamination at ISR sites by stricter application of groundwater standards and more extensive monitoring to ensure that groundwater restoration will endure, is a reasonable and responsible approach to achieving this goal.

1. What are the environmental impacts of uranium ISR?

As noted earlier, ISR facilities affect the environment in ways that are both distinct from, and more complicated than, conventional mill tailings sites. The alteration of

[24] "Protecting the Nation's Ground Water: EPA's Strategy for the 1990s," 21Z-1020, July 1991.

large subsurface areas through injection of chemical solutions also has the potential to cause changes in groundwater at significant distances downgradient. The migration of constituents liberated from the subsurface is controlled during the operational phase through the use of extraction wells.[25]

Once uranium recovery operations at a wellfield are complete, efforts to restore groundwater in the wellfield begin. Without such efforts, contaminants could migrate hydrologically downgradient from the ISR site. Restoration efforts largely consist of injecting and extracting water to flush out the remaining mobilizing solutions (*i.e.*, lixiviant) and chemical treatments designed to reverse the chemical process and return the prevailing chemical conditions (oxidizing) in the subsurface to their preoperational reducing state.

Long-term environmental impacts may result if the restoration process does not return the aquifer to its preoperational state, or if the restored levels do not persist over time and groundwater degrades through the slow release of residual contaminants. We have concerns regarding both of these situations. Most ISR sites historically have been unable to meet restoration goals for all constituents

[25] Extraction wells are also used during the restoration phase to control the migration of constituents liberated from the subsurface.

even after extensive effort.[26] Because the past practice of monitoring after restoration has typically been for a very limited time period, we do not know if the goals that are met for the short-term are maintained for a longer time.

Some of our additional concerns relate to the restoration process itself, which is extremely complex and difficult to control. The fact that significant quantities of uranium and other constituents have been removed from the natural setting may affect flow patterns and create discontinuities that further complicate or retard the restoration process. Incomplete restoration efforts may result in pockets of slowly leaching contaminants.

We also have concerns that relate to the implementation of groundwater protection programs. In the absence of ISR-specific standards, NRC and its Agreement States have worked through guidance and license conditions to address these issues.

Based upon the information that we have reviewed, we believe a more rigorous approach is warranted for establishing restoration goals and demonstrating the continued stability of groundwater after restoration. In particular, it is our position that post-restoration monitoring periods have not been of sufficient duration to

[26] Hall, Susan (2009). "Groundwater Restoration at Uranium In-Situ Recovery Mines, South Texas Coastal Plain." U.S. Geological Survey.

provide the necessary level of confidence that groundwater quality will not degrade to unacceptable levels and promote contaminant migration over time, after the license has been terminated and the licensee has sold the land or returned the property to the original owner.

We recognize that it is difficult to reach a definitive conclusion regarding long-term contamination because post-restoration monitoring typically occurs for only a relatively short time, a few years at most; nevertheless, we believe the available information supports our judgment in this matter. Because the lixiviant used during operations oxidizes not just the uranium but the entire production zone, the later addition of reducing agents to restore the wellfield may be just a temporary fix. As the reducing agents migrate out of the production zone, re-oxidation of the uranium in the "restored" wellfield may occur if the natural reducing agents originally present in the production zone (*e.g.*, pyrite) were sufficiently depleted during ISR operations. Over time, incoming oxidized groundwater may remobilize any remaining uranium, and other constituents temporarily immobilized during the ISR restoration process, and move them downgradient, outside the wellfield. To determine if re-mobilization of constituents precipitated by the restoration process will occur, longer term monitoring of the site is warranted.

2. What analysis has EPA done to support the proposal?

There are no known publications in the open literature on the long-term stability of ISR sites.[27] We have evaluated exposure scenarios and exposure pathways for radionuclides and found that migration of contaminants within the ore-bearing aquifer and slow movement of contaminants into upper aquifers through discontinuities or disruptions (*e.g.*, abandoned boreholes) and other possible failure scenarios (leaks, spills, etc.) have the potential to result in significant exposures to individuals outside the production areas.[28] These assessments suggest that a more robust regulatory approach is advisable in order to prevent the occurrence of various failure scenarios that may occur during ISR operations and mitigate the potential adverse effects of any such failures.

In examining the technical literature pertaining to ISR operations, we have found that some modeling studies indicate that the uranium recovery operations can result in the development of slow groundwater movement pathways through the wellfield, as well as showing the persistence of injected lixiviant material within the production zone.

[27] Borch, T., N. Roche and T.E. Johnson (2012), "Determination of Contaminant Levels and Remediation Efficacy in Groundwater at a Former In Situ Recovery Uranium Mine." Journal of Environmental Monitoring, 14:1814-1823.
[28] EPA (2012), "Groundwater Modeling Studies at In Situ Leaching Facilities and Evaluation of Does and Risks to Off-Site Receptors from Contaminated Groundwater."

These results suggest that the typically short post-remediation monitoring periods prior to license terminations may fail to detect later contaminant migration out of the wellfield along these slow transport paths. Longer post-restoration monitoring periods and requirements are proposed in the standards to address these situations. Statistical analyses of well water chemistry data over a relatively short time (a year or two) alone does not in itself demonstrate that slow pathways are absent or that the chemistry of the groundwater will remain in a chemically reduced state over the long term. Only a combination of longer post-restoration monitoring coupled with geochemical modeling using site specific data can provide confidence that the ISR site poses no long-term hazards.

We have also examined various statistical approaches that might be suitable for evaluating post-restoration groundwater stability.[29] We gave special attention to the data requirements to be utilized in achieving a given level of statistical confidence that would indicate stability over a specified period of time. While we do not recommend any specific statistical method be applied universally to all ISR situations (because the hydrogeology and geochemistry of ISR sites are not uniform by nature), we do believe that the method(s) chosen must be justified by the quality and

[29] EPA (2013), "Considerations Related to Post Closure Monitoring of Uranium In-Situ Leach/In-Situ Recovery Sites."

quantity of the field data collected. Linear regression techniques are typically used to examine time series measurements (concentrations of groundwater constituents measured over time intervals) for the presence of trends in the data (*i.e.*, to determine if the data show increases or decreases in the measured concentrations over time). While this type of analysis is relatively simple and can be used for quick screening to identify the presence of strong linear trends, it is often not sufficiently rigorous when used with field data because of significant limitations on the data sets. For linear regression assessments, the data must have a normal distribution and constant variance (two requirements that are difficult to demonstrate with field data). The data must have few or no values below the analytical detection limits for the measured parameter, and minimal outliers in the data or cyclical patterns (*e.g.*, no detectable seasonality in the case of shallow aquifers). Field data rarely meet these conditions. Parametric and nonparametric techniques are more rigorous than simple linear regression but also have specific data demands. Parametric statistical tests require more complete data sets but require less data overall to reach the same statistical confidence levels as non-parametric tests, which are more tolerant of data shortcomings such as missing data in a series of measurements. Less than perfect data sets are common in field efforts, making non-parametric techniques potentially more useful in practice. These methods are extensively assessed in the background information document.[30] The EPA document, "Statistical Analysis of Groundwater Monitoring at RCRA Facilities – Unified Guidance Document" (2009), offers appropriate guidance on the level of confidence to be attained for demonstrating stability before regulatory decisions are made to terminate the operating license and release the wellfield for other uses. For RCRA monitoring results, where the intent is to ensure contaminants do not migrate out of the area and into surrounding potable groundwater sources, a confidence level of 95 percent is expected to support a regulatory action to terminate the permit.[31] We believe an equivalent degree of confidence in the long-term stability of a restored ISR wellfield is appropriate.

3. What came out of the Advisory from EPA's Science Advisory Board?

In early 2011, we approached EPA's Science Advisory Board (SAB)[32] to obtain advice regarding the complex scientific and technical issues related to groundwater protection at ISR sites. The SAB is an independent advisory body established by Congress in 1978 with a broad mandate to

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[30] EPA (2013). "Considerations Related to Post Closure Monitoring of Uranium In-Situ Leach/In-Situ Recover Sites."
[31] 40 CFR 264.97 (h) & (i)
[32] http://yosemite.epa.gov/sab/sabpeople.nsf/WebCommittees/BOARD

advise the Agency on technical matters. The SAB typically interacts with EPA programs through one of the following processes: (1) a consultation, which is a broadly conceptual evaluation at the early stages of an action; (2) an advisory, which is typically a more detailed evaluation to address specific technical issues during development of a rule or technical guidance; or (3) a review, which is a detailed evaluation of a completed action to determine how the Agency incorporated science into its decision-making. The SAB will often conduct a review of an action on which it had previously weighed in through a consultation or advisory.

We sought an advisory with the Radiation Advisory Committee (RAC), which is the committee of the SAB specializing in radiation issues. For purposes of this advisory, the RAC was augmented with several additional experts with specialized knowledge of geochemistry or hydrogeology pertinent to ISR.

We prepared a report outlining the technical issues involved in groundwater protection during the life cycle of an ISR facility[33] and requested that the RAC comment on the following:

1) The technical areas described in the report and their relative importance for designing and implementing a

[33] EPA (2011), "Draft Technical Report on Considerations Related to Post-Closure Monitoring of Uranium In-Situ Leach/In-Situ Recovery (ISL/ISR) Sites."

groundwater monitoring network;

2) The proposed approaches for characterizing baseline groundwater chemical conditions in the pre-operational phase and proposed approaches for determining the duration of such monitoring to establish baseline conditions;

3) The approaches considered for monitoring in the post-restoration phase and the approaches considered for determining when groundwater chemistry has reached a "stable" level; and

4) Suitable statistical techniques that would be applicable for use with uranium ISR applications (particularly for the areas in items 2 and 3 above), as well as the subsequent data requirements for their use.

Public meetings/teleconferences of the advisory committee were held from July 12, 2011 through December 21, 2011, and included a two-day meeting in July 2011 with presentations by EPA management and staff, discussions with the RAC members, comments from members of the public, and initial reporting assignments for the RAC. NRC staff also attended the meetings and provided valuable input for the committee.

The RAC submitted its final report on February 17, 2012.[34] EPA responded to each recommendation and updated its

[34] All information related to the advisory is located at http://yosemite.epa.gov/sab/sabproduct.nsf/c91996cd39a82f648525742400690127/0314cef928df63cc8525775200482fa3!OpenDocument

draft report as part of the technical background information document for this proposal.[35] Among the more prominent RAC recommendations are the following:

- Identify indicators, both chemical and radioactive, for establishing conditions pre- and post-operationally, not limited to those with regulatory limits, but also including non-hazardous constituents that can affect the behavior of, or serve as surrogates for, constituents of interest;
- Devote at least as much effort to defining background groundwater conditions as to post-operational trend monitoring;
- Consider challenging and fluctuating ambient circumstances in background characterization;
- Build in flexibility to modify the design and implementation of monitoring programs as new information becomes available;
- Carefully qualify the meaning of "return to preoperational groundwater quality;"
- Match sampling frequency and duration to information needs for model confirmation;
- Present a survey of methods to determine sufficient

[35] EPA (2013), "Considerations Related to Post Closure Monitoring of Uranium In-Situ Leach/In-Situ Recovery Sites."

well number and density; and

- Select statistical evaluation approach in terms of strengths and weaknesses to suit questions to be answered.

We believe today's proposal appropriately addresses these issues and incorporates the advice of the RAC.

4. What efforts have the Nuclear Regulatory Commission taken recently?

NRC regulates uranium mills and mill tailings in accordance with Appendix A to 10 CFR part 40.[36] Appendix A incorporates EPA's 40 CFR part 192 standards. NRC has developed guidance related to ISR activities[37] and has implemented facility requirements through license conditions. Agreement States regulating ISR facilities have taken a similar approach.

In recent years, NRC has recognized the desirability of ISR-specific regulations. NRC has been concerned with the potential for duplicative or conflicting groundwater protection requirements at ISR sites where NRC implements UMTRCA requirements but the EPA, or a state with primary

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[36] "Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material From Ores Processed Primarily for Their Source Material Content." 10 CFR part 40 more broadly covers "Domestic Licensing of Source Material."

[37] For example, see NRC (2003). "Standard Review Plan for In Situ Leach Uranium Extraction License Applications (NUREG-1569)." Available at http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1569/.

enforcement responsibility ("primacy"), also regulates the injection associated with ISR through its Underground Injection Control (UIC) authorities, which are derived from EPA under the Safe Drinking Water Act (see Section II.F.1 of this document). In 2003, NRC staff recommended that NRC enter into Memoranda of Understanding (MOU) with the affected states (at the time, Wyoming and Nebraska) to defer active regulation of groundwater to the states.[38] This recommendation was approved by the Commission.[39]

Upon further investigation, however, NRC staff reported to the Commission that "the Nebraska and Wyoming groundwater protection programs were found to be not equivalent to the NRC's groundwater protection program." Specifically, both states required restoration of groundwater to "a quality of use" consistent "with the uses for which [it] was suitable prior to" the ISR operation, rather than to levels consistent with NRC and EPA restoration standards.[40]

After considering this information, the Commission determined in 2006 that the appropriate action was "initiation of a rulemaking effort specifically tailored to

[38] NRC (2003). "Options and Recommendations for NRC Deferring Active Regulation of Ground-Water Protection at *In Situ* Leach Uranium Extraction Facilities." SECY-03-0186.
[39] NRC (2003). "Options and Recommendations for NRC Deferring Active Regulation of Ground-Water Protection at *In Situ* Leach Uranium Extraction Facilities." Staff Requirements-SECY-03-0186.
[40] NRC (2006). "Status of the Development of Memoranda of Understanding with Nebraska and Wyoming Regarding the Regulation of Groundwater Protection at Their *In Situ* Leach Uranium Recovery Facilities." SECY-05-0123.

groundwater protection programs at *in situ* leach (ISL) uranium recovery facilities." Further, the Commission directed that "[t]he staff should focus on eliminating dual regulation by the NRC and EPA of groundwater protection. The NRC should retain its jurisdiction over the wellfield and groundwater under its Atomic Energy Act authority, but should defer active regulation of groundwater protection programs to the EPA or the EPA-authorized state through EPA's underground injection-control permit program."[41]

EPA has always held the position that UMTRCA and the Part 192 standards are separate and equally applicable authorities that NRC is obligated to implement at ISR facilities. Reliance on the requirements of the UIC program alone would not adequately address groundwater protection at ISR facilities, given that the purpose of the UIC program is to prevent endangerment of underground sources of drinking water (USDWs), not to address restoration of groundwater. Moreover, if the groundwater is not considered a USDW, as is typically the case at ISR facilities, it is not protected under the Safe Drinking Water Act (SDWA). States can implement more stringent requirements than the national UIC requirements. This situation would likely lead to inconsistent levels of protection; further, as NRC

[41] NRC (2006). "Regulation of Groundwater Protection at *In Situ* Leach Uranium Extraction Facilities." Staff Requirements – COMJSM-06-001.

discovered, states with authority to implement the UIC program may not have groundwater protection requirements consistent with those that have been applied to conventional mills. EPA decided to address groundwater protection at ISR facilities by amending its UMTRCA standards, as we are proposing to do today. The Commission subsequently decided that the NRC rulemaking should be deferred until EPA's revised standards are final.[42]

F. What other EPA statutes and regulations are relevant?

There are several other EPA environmental statutes and regulations that are applicable to ISR facilities and operations. The Safe Drinking Water Act, Clean Water Act, Clean Air Act and Resource Conservation and Recovery Act are all detailed below. It should be noted that UMTRCA requires us to establish protections consistent with the requirements of the Resource Conservation and Recovery Act.

1. Safe Drinking Water Act (SDWA)

The Safe Drinking Water Act (42 U.S.C. 300f et seq., 1974) is the main federal law that addresses drinking water. Under the SDWA, EPA sets health-based standards for drinking water to protect against naturally occurring and anthropogenic contaminants that may be found in drinking water. EPA and States work together to implement those

[42] NRC (2011). "NRC Regulatory Agenda: Semiannual Report, July - December 2010." NUREG-0936; Vol. 29, No. 2.

standards at public water systems.[43] Implementing regulations in 40 CFR part 141 include the establishment of national primary drinking water standards.

The SDWA also addresses sources of drinking water, including underground sources, which may be used by public water systems or private well owners. As required by the SDWA, EPA established regulations for UIC programs to prevent underground injection that endangers drinking water sources.[44] Under this program, the Agency has a permit system to prevent endangerment of USDWs. It prohibits any injection activity that allows the movement of fluid containing any contaminant into underground sources of drinking water, if the presence of that contaminant may cause a violation of any primary drinking water regulation or otherwise adversely affect the health of persons. EPA's UIC regulations, including permit requirements, are found at 40 CFR parts 144-148. They address construction, operation, monitoring, reporting, and plugging and abandonment of injection wells to prevent the movement of fluids into any USDW.[45]

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[43] SDWA does not regulate private wells that serve fewer than 25 individuals.
[44] SDWA Section 1421(c)(2)(C)(2) states: "Underground injection endangers drinking water sources if such injection may result in the presence in underground water which supplies or can reasonably be expected to supply any public water system of any contaminant, and if the presence of such contaminant may result in such system's not complying with any national primary drinking water regulation or may otherwise adversely affect the health of persons." 42 U.S.C. 300h(d)(2)
[45] EPA defines six classes of underground injection well. Uranium in-situ recovery operations are permitted as Class III wells. 40 CFR

EPA's UIC regulations for Class III wells protect USDWs by prohibiting the movement of any contaminant into the underground source of drinking water (*e.g.*, injection of fluids or release or migration of naturally occurring contaminants into an underground source of drinking water). A USDW is defined in EPA regulations as any aquifer or its portion (a)(1) which supplies a public water system or 2) which contains a sufficient quantity of groundwater to supply a public water system; and (i) currently supplies drinking water for human consumption; or (ii) contains fewer than 10,000 mg/l total dissolved solids; and (b) which is not an exempted aquifer. An aquifer or a portion of an aquifer may be exempted from the protections afforded USDWs if (a) it does not currently serve as a source of drinking water and (b) it cannot now and will not in the future serve as a source of drinking water because one of four specified conditions is met,[46] or the total dissolved solids content of the groundwater is more than 3,000 and less than 10,000 and it is not reasonably expected to supply a public water system. If an underground injection well is used for injection into an exempted aquifer or a portion of an exempted aquifer, it is still regulated to protect the portions of the aquifer and nearby aquifers that are not

146.5(c)(2)

[46] The presence of minerals or hydrocarbons that are, or are expected to be, commercially producible, is one of these specified conditions; this would likely be the situation at a proposed ISR site. 40 CFR 146.4

exempted. The construction of a Class III injection well at an ISR facility requires an UIC permit be obtained. In issuing the Class III UIC permit, the permitting authority must ensure that injection does not occur into a USDW. Because uranium ISR always involves injection into an underground aquifer, the receiving aquifer must not meet the definition of a USDW. Typically, this means that an aquifer exemption must be obtained. The scope of coverage of an aquifer exemption request is typically the portion of the aquifer affected by the activity.

EPA has established minimum requirements for states or tribes to obtain authority to implement the UIC program.[47] To obtain "primacy" to implement the UIC program for Class III wells, states or tribes must adopt and submit to EPA for approval, UIC Class III injection well requirements that are at least as stringent as EPA's minimum requirements. The state or tribe may establish and implement requirements more stringent than the EPA UIC regulations, but not less stringent than the minimum federal requirements. Further, primacy states have the authority to identify and propose aquifers for exemption as part of its initial UIC program submission, or subsequent to program approval; however, these proposed exemptions generally must be affirmatively approved by the EPA.[48] Aquifer exemptions have been a source

[47] 40 CFR part 145, "State UIC Program Requirements."
[48] 40 CFR 144.7(b)(2) & (3).

of confusion regarding the applicability of our UMTRCA standards, which we hope to clarify today. There are no UIC requirements for restoration of the exempted portion of the aquifer, but an aquifer exemption does not eliminate the need to comply with the requirements of UMTRCA. The aquifer exemption provides relief from certain UIC requirements under the SDWA, thereby allowing injection into aquifers that would otherwise meet the definition of a USDW. The part 192 standards, however, are promulgated under a different statute. Therefore, an aquifer exemption under the SDWA does not relieve the owner/operator of the obligation to remediate environmental contamination resulting from activities regulated under UMTRCA. Today's proposal clarifies that EPA standards issued pursuant to UMTRCA do apply within the exempted portion of the aquifer.

2. Clean Water Act (CWA)

The Clean Water Act (33 U.S.C. §1251 et seq., 1972) requires the establishment of water quality standards for, and regulation of pollutant discharges into, waters of the United States. Under the CWA, EPA has implemented pollution control programs, such as setting technology-based wastewater discharge limitations and standards for various industries. Subpart C of 40 CFR part 440 provides technology-based effluent limitations guidelines and standards applicable to discharges from mills from which uranium, radium and vanadium are extracted. Permits for discharges to surface waters must include applicable technology-based limits, as well as any more stringent water quality-based effluent limits necessary to achieve water quality standards established under section 303 of the CWA, including State narrative criteria for water quality.

3. Clean Air Act (CAA)

EPA regulates radionuclide emissions through its authority under the CAA, 42 U.S.C. 7401 et seq. The Agency has promulgated regulations for controlling radon emissions from uranium byproduct materials located at uranium recovery facilities, including ISR sites, at 40 CFR part 61, Subpart W.

4. Resource Conservation and Recovery Act (RCRA)

The Resource Conservation and Recovery Act (42 U.S.C. §6901 et seq.) was passed in 1976 as an amendment to the Solid Waste Disposal Act of 1965, to ensure that solid wastes are managed in an environmentally sound manner. RCRA gives EPA the authority to control hazardous waste from "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste (Subtitle C). RCRA also set forth a framework for the management of non-hazardous solid wastes (Subtitle D). RCRA has been further amended to extend its application; for example, the 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances.

UMTRCA requires that generally applicable standards promulgated under its authority by EPA for non-radiological hazards be consistent with the standards issued under Subtitle C of the Solid Waste Disposal Act (now RCRA) that are applicable to those same hazards. The most appropriate RCRA regulations that bear on the ISR process are contained in 40 CFR part 264. These regulations deal with functionally relevant issues such as requirements for: the siting, design and operation of impoundments; monitoring groundwater around land-based storage and disposal facilities; detecting contaminant releases and conducting subsequent corrective actions; and establishing the duration of compliance monitoring periods. These requirements are easily applied to conventional mill tailings impoundments, which are to be constructed to RCRA standards, although they are expected to remain under institutional control for much longer periods.[49] Similarly, we believe many of the requirements and concepts should be applicable to the long-term behavior of an ISR site after uranium extraction has ceased and the operators have made efforts to restore the wellfield to

[49] These requirements also apply to any uranium byproduct impoundments (*i.e.*, ponds) that are removed at the end of licensed operations.

conditions that existed before the mining operation began. Conceptually at that stage there is similarity between a closed hazardous waste disposal facility and a restored ISR wellfield in the sense that both strive to avoid off-site migration of contaminants. The intent of the groundwater monitoring efforts at these two types of facilities share the common objective of verifying that containment of contamination meets expectations. The location of compliance point(s) for monitoring data collection, performance measures for assessing compliance with regulatory requirements, duration of the monitoring program and the extent of data necessary for regulatory decision-making are areas that we believe can be adapted to better fit the unique aspects of the ISR application. These subjects are discussed in the next section.

III. Summary of Today's Proposal

Today's proposal is limited to the following items. First, we are proposing new standards for byproduct materials produced by uranium ISR facilities. Second, we are proposing to amend an existing provision only as necessary to address a judicial decision, an outdated reference, known typographical and grammatical errors, and a change to the title. At this time, we request public comment only on these proposed standards and amendments. We are not requesting, and will not respond to, public comments related to any other provisions since they are beyond the scope of today's proposal. The rationale for these elements of our proposal is discussed in Section IV of this document.

A. Proposed standards (Subpart F)

1. Proposal of new subpart – Subpart F-Public Health, Safety and Environmental Protection Standards for Byproduct Materials Produced by Uranium In-situ Recovery

A new subpart F is being proposed that would set standards that would apply to uranium ISR facilities only.

2. Addition of new section on applicability – § 192.50 Applicability.

We are proposing applicability language under subpart F that specifies the subpart will apply to the management of uranium byproduct materials during and following the processing of uranium ores using ISR methods.

3. Addition of new section containing definitions - § 192.51 Definitions and cross-references.

To help ensure consistency with subparts A, B, C, D and E, all terms in the proposed subpart shall carry the same meaning as previously defined, unless otherwise specified. To help ensure clarity, the new subpart will contain numerous definitions specific to ISR. The following terms are defined:

Terminology
Adjacent Aquifer
Alternate Concentration Limit (ACL)

Aquifer
Background
Constituent
Exceedance
Excursion
Excursion Monitoring Well
Exempted Aquifer
Extraction Well
Injection Well
In-Situ Recovery
Lixiviant
Maximum Constituent Concentration
Maximum Contaminant Level (MCL)
Monitoring Wells
Operational Phase
Overlying Aquifer
Parameter
Point(s) of Compliance
Point(s) of Exposure
Post-Restoration Phase
Preoperational Monitoring
Production Zone
Restoration (Act of)
Restoration Goal
Restoration Phase
Site
Stability Phase
Underlying Aquifer
Upper Control Limit (UCL)
Wellfield

4. Addition of new section detailing standards - § 192.52 Standards for application during processing

operations and prior to the end of the closure period.

In the new subpart, EPA proposes to specify the minimum 13 constituents for which groundwater protection standards must be met. The list includes the following: arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, nitrate (as N), molybdenum, combined radium-226 and radium-228, uranium (total), and gross alpha-particle activity (excluding radon and uranium). The concentration of each listed constituent must remain at or below the most protective standards under the SDWA (40 CFR 141.61, 141.62, 141.66, 141.80 and 143.3), values from RCRA standards (40 CFR 264.94), or Part 192, Table 1, except in cases where the measured preoperational wellfield background concentration is higher than the most stringent value in the applicable regulations. In such cases, the measured background concentration will serve as the restoration goal. The proposed language allows for the regulatory agency to set standards for additional constituents as necessary, consistent with site conditions.

The new subpart also describes the process for requesting and approving alternate concentration limits (ACLs) after restoration has taken place.

5. Addition of new section discussing monitoring requirements - §192.53 Monitoring Programs.

In addition to the constituents to be monitored at ISR facilities, the new subpart also details the specific requirements of monitoring programs to be conducted during the preoperational, operational, restoration, and post-restoration phase.

6. Addition of new section establishing requirements for corrective actions - § 192.54 Corrective action programs.

Should the proposed groundwater standards be exceeded at the excursion monitoring wells or post-restoration compliance wells at any licensed ISR site, we propose to require that a corrective action program be put into place as soon as is practicable and no later than 90 days after an exceedance is discovered. Similar to the approach taken in subpart D, we propose that the corrective action program put into place meet the specifications of § 264.100.

7. Addition of new section detailing the effective date of the new subpart - § 192.55 – Effective Date

We are proposing that the rule go into effect 60 days after it is promulgated in the Federal Register, the legal minimum amount of time between promulgation of the new subpart and its effective date.[50]

<u>B. Other proposed amendments</u>

1. Revision to Rule Title – Public Health, Safety and Environmental Protection Standards for Byproduct Material

[50] See 42 U.S.C. 2022(c)(3).

We are proposing to make changes to the title of the rule itself so that it more closely aligns with the requirements set forth in UMTRCA.

2. Revision to Subpart C – Implementation

In an effort to address an outdated reference, EPA proposes to remove mention of the Grand Junction Remedial Action Criteria (10 CFR 712); the criteria were removed from the CFR between 1981 and 1982. In addition, EPA proposes to delete language citing certain remedial options that "may provide reasonable assurance of" radon decay product concentration reductions. The final report for the Grand Junction Remedial Action Program, issued in 1989, stated that the methods were not effective over the long term.

3. Revision to Subpart D – Standards for the Management of Uranium Byproduct Materials

EPA proposes to amend the heading of Subpart D. The proposed amendment will remove an inaccurate citation of EPA's authority. In order to correct certain typographical and grammatical errors that have been identified in Subpart D since promulgation, EPA proposes the following technical corrections:

Section	Proposed technical correction and reason
§ 192.31(a)	Replace "Uranium Mill Tailings Rediation Control Act" with "Uranium Mill Tailings Radiation Control Act" to correct a typographical error

§ 192.31(f)	Replace "pile containing uranium by product materials" with "pile containing uranium byproduct materials" to correct a typographical error
§ 192.32(a)(2)(v)	Replace "laser fusion, of soils, etc." with "laser fusion of soils, etc." to correct a grammatical error

EPA is also proposing to modify § 192.32(a)(2)(v) in order to delete the NRC requirement to obtain concurrence from EPA before NRC may approve an alternate requirement or proposal under AEA section 84(c).[51] This portion of § 192.32(a)(2)(v) was effectively struck down by the Tenth Circuit Court of Appeals in *Environmental Defense Fund vs. U.S. Nuclear Regulatory Commission*, 866 F.2d 1263 (10th Cir. 1989).

IV. What is the Rationale for Today's Proposal?

Groundwater is a valuable and dwindling resource, particularly in western states where most ISR activities are anticipated. EPA views protecting groundwater as a fundamental part of its mission. EPA's Groundwater Protection Strategy, first issued in 1984 and updated in 1991, established the Agency's policies that 1) protecting groundwater from contamination is preferable to remediating it after contamination has occurred and 2) drinking water standards should be used, where practicable and appropriate,

[51] See 42 U.S.C. § 2114(c).

as benchmarks for groundwater protection.[52] Particularly in cases where groundwater is directly threatened by an activity, as it is by the ISR technology, EPA believes it has a special duty to ensure that its protection policies are emphasized and reflected in its regulatory requirements.

We anticipate the objection that the presence of uranium deposits typically results in groundwater of poor quality, and not a pristine source of drinking water. We recognize that this is often the case, and that the volume of water affected by the mineralized zone may be significant. We do not, however, see this as a reason to allow this groundwater to be further degraded. The scarcity of groundwater is leading some communities to consider exploiting sources of water that previously would have been considered non-potable, using advanced treatment to make it suitable for livestock or human consumption. Since such advanced treatment may not be economically feasible for some communities, it is all the more important to prevent, as much as reasonably possible, additional degradation of the groundwater. ISR facilities use significant volumes of water during both operations and restoration. We believe it is reasonable to make every effort to ensure that ISR activities leave groundwater in no worse condition than the ISR operators found it.

[52] "Protecting the Nation's Ground Water: EPA's Strategy for the 1990s," 21Z-1020, July 1991.

A. How Does Today's Proposal Relate to Existing 40 CFR Part 192?

In 1983, EPA promulgated regulations at 40 CFR part 192 in response to the statutory requirements of UMTRCA. At the time, uranium recovery from ore was done almost exclusively by conventional milling processes, where at most a few pounds of uranium were recovered for each ton of ore mined and processed. The wastes from the milling process (the tailings and raffinates, *i.e.*, uranium byproduct materials) were disposed of in large piles on the surface at mill sites, posing contamination risks to surface water, groundwater, and soils, both on and off site. Liquid wastes were often discharged into rivers. Contaminants of concern consisted primarily of radionuclides and non-radioactive metals, radon gas and organics. Concerns that these tailings piles would be a continuing source of radiation exposure and environmental contamination unless properly reclaimed and managed were the driving force behind the passage of UMTRCA. The statue's intent was to contain tailings in engineered impoundments to prevent the further dispersion and misuse of the material. This measure would also protect uncontaminated aquifers from becoming contaminated by the uranium mill tailings impoundments and prevent radon emissions through performance specifications for radon barriers (covers). Because the major environmental risk at that time was perceived to come from the conventional uranium mill tailings, which already existed in large volumes, other uranium recovery technologies, including ISR, received little attention.

As stated earlier, ISR has surpassed conventional milling as the dominant form of uranium extraction in the United States and is expected to predominate in the future. The ISR process presents different environmental concerns from conventional milling. ISR does not generate large volumes of solid waste materials or require permanent tailings impoundments. The ISR process does, however, directly alter groundwater chemistry, posing the challenge of groundwater restoration and long-term subsurface geochemical stabilization after the ISR operational phase ends. With ISR, the "milling" of uranium ore is performed within the ore zone aquifer by injection of lixiviants. As stated earlier, the lixiviants can also liberate other elements, particularly metals that are often found co-located with uranium deposits. Their migration outside the production zone can potentially contaminate surrounding aquifers. Furthermore, when processing of the ore zone is no longer economically viable, ISR operators can release the site for future use, either by selling the land or returning the property to the original owner. The operators are required to restore the aquifer to its original geochemical conditions, to the extent possible, and to show some level of stability in the geochemistry of the production zone before terminating the license and making the site available for other uses. Whereas conventional mill tailings piles are under perpetual institutional control, current NRC regulations allow for ISR sites to terminate their licenses, essentially ending regulatory oversight of the site.

Today, EPA is reaffirming that ISR facilities are subject to the 40 CFR part 192 requirements. We seek to provide clear direction on how to monitor groundwater prior to operations and following restoration, and how to demonstrate geochemical stability at these sites.

We believe there has been some uncertainty about how to apply the current standards, which are more targeted to conventional mills. In addition, there has been confusion about applicability of UMTRCA restoration requirements at aquifers that have been exempted from the standards of the SDWA. With the prospect of many additional ISR facilities beginning operations, we believe it is necessary to clarify these issues. Therefore, we are proposing additional groundwater protection provisions to 40 CFR part 192 that are specific to uranium ISR facilities. We believe these provisions are necessary to ensure that ISR sites are not released from regulatory control until it can be reasonably demonstrated that groundwater will not degrade over time.

Specifically, we are proposing provisions that will result in long lasting protection of surrounding aquifers. The provisions specify how to determine preoperational background conditions that will be used to set appropriate restoration goals, applicable standards and alternate concentration limits. We are also proposing specifications for post-restoration groundwater stability monitoring. We view these as the key elements in ensuring that ISR sites do not become a source of continuing or widespread contamination after the operation is terminated.

Sufficient data must be collected to characterize the conditions existing within and outside the proposed production zone to set appropriate restoration goals that account for the variability in geochemistry frequently encountered in mineralized regions. Subsequent to the end of uranium production, the regulator must ensure that alternate standards are approved only after restoration has been attempted and it is clearly demonstrated that the initial groundwater protection standard(s) cannot be achieved, or once achieved, cannot be maintained. Such approval should take place only after the operator has made reasonable and satisfactory efforts to achieve and maintain the initial standard(s). Whether the initial goals are met or alternate standards are approved, conditions must be shown to be stable and groundwater quality must not degrade over time, as is possible when: lingering amounts of lixiviant solution remain in isolated pockets within the wellfield; reducing conditions are not fully reestablished; and/or the post-restoration monitoring period is too short compared to groundwater movement through the aquifer. Therefore, the operator must monitor groundwater at the site for a sufficiently long period after restoration is complete and use sufficient statistically significant data to provide a reasonable demonstration that long-term stability has been achieved. This demonstration can include geochemical modeling to confirm the persistence of stability of the groundwater chemistry.

We understand that there has been some confusion about the applicability of the aquifer exemption process to restoration requirements at ISR sites. We further recognize that the application of the existing standards in 40 CFR part 192 to ISR sites is not as straightforward as it could be. Nevertheless, we believe there is sufficient information available to indicate that practices related to groundwater protection at ISR facilities have not been sufficiently rigorous to provide confidence either that groundwater is being restored appropriately or that such restoration will persist into the reasonably foreseeable future.[53,54,]

[53] Hall, Susan (2009). "Groundwater Restoration at Uranium In-Situ Recovery Mines, South Texas Coastal Plain." U.S. Geological Survey.
[54] Darling, Bruce (2008). "Report on Findings Related to the Restoration of Groundwater at In-Situ Uranium Mines in South Texas." Southwest

[55] We believe today's proposal will address these issues in a manner that is both logical and implementable;[56] we solicit comment on these views.

B. What groundwater protection standards are we proposing for ISR facilities?

We are proposing today to establish groundwater protection standards consistent with those applied to conventional mills in 40 CFR part 192, subpart D. That is, the owner/operator will use as the applicable standard during restoration and post-restoration stability monitoring either (1) the background concentrations of groundwater constituents measured prior to the start of the ISR operational phase; or (2) a specified regulatory level, whichever is higher. In certain circumstances, the owner/operator may request that the regulatory agency approve an alternate concentration limit.

1. Generally applicable groundwater standards

We emphasize again that the groundwater protection standards currently found in 40 CFR part 192 apply to ISR sites. These standards address both radiological and non-

Groundwater Consulting, LLC.

[55] Fettus, G. and M.G. McKinzie (2012). "Nuclear Fuel's Dirty Beginnings: Environmental Damage and Public Health Risks from Uranium Mining in the American West." Natural Resources Defense Council.

[56] It should be noted that we are not proposing to establish requirements related to the technical aspects of groundwater restoration (*i.e.*, what methods to use for restoration or which statistical methods to use for assessing temporal stability of the groundwater chemical state).

radiological constituents. The standards applicable to non-radiological constituents adopted the requirements for groundwater monitoring at RCRA hazardous waste sites.[57] These generally applicable standards were originally based upon EPA's 1976 Maximum Contaminant Levels (MCLs) in drinking water (40 CFR part 141).[58] EPA further specified radiological and non-radiological constituents of concern at mill tailings sites. Following the same approach, we are proposing today to specify the constituents that must be monitored prior to operations and after restoration at ISR sites, as appropriate. The required constituents are those included in Table 1 of 40 CFR part 192, subpart A, with the exception of the six pesticides.[59]

We are not proposing to establish new numerical standards in the rule. EPA's preferred option for carrying over and updating the groundwater protection standards in the new ISR-specific subpart F is to incorporate, by reference, the most protective standards under the SDWA (40 CFR 141.61, 141.62, 141.66, 141.80 and 143.3), values from RCRA standards (40 CFR 264.94), and the maximum constituent concentrations found in Table 1 to subpart A (40 CFR 192).

[57] 40 CFR 264.94, Table 1.
[58] 47 FR 32285, July 26, 1982. The use of MCLs as standards for groundwater protection anticipate the Agency's Groundwater Protection Strategy, first developed in 1984 and updated in 1991. Under the Strategy, MCLs provide a benchmark for groundwater protection. Contamination of groundwater above MCLs is viewed as a failure of pollution prevention.
[59] Endrin, lindane, methoxychlor, toxaphene, 2,4-D, and 2,4,5-TP Silvex. These constituents are unlikely to be present at ISR sites.

By incorporating the standards by reference, the new subpart F would automatically update if those concentration values changed in the standards under SDWA or RCRA and thereby, be self-implementing. Owner/operators currently in restoration at a given wellfield would continue to be held to the standard(s) in place at the time of licensing, unless the regulatory agency determines otherwise. This option would make the groundwater protection standards under the proposed subpart consistent with all current and future standards under SDWA and RCRA. We believe that this approach will more effectively keep the groundwater protection standards current with the Agency's policies. The standards in the existing portion of 40 CFR part 192 are outdated for arsenic and uranium, both of which have had new MCLs established since the year 2000. Today's proposal would update the standards for arsenic and uranium. Should the Agency propose to update its MCLs or RCRA standards at some point in the future, stakeholders will have the opportunity to comment on the potential impacts to ISR activities. We request comments on this approach.

We also request comment on the alternative approach of placing a static table of restoration goals in the new subpart F. The table would list the 13 required constituents for which groundwater protection standards must be met, and also provide the specific numeric concentration value associated with each constituent. If this option is promulgated in the final rule, the standards would not automatically update with any future changes to standards under the SDWA or RCRA but remain static. Under this approach, the Agency would initiate future changes to standards through a notice-and-comment rulemaking specifically for 40 CFR part 192.

In order for an ISR operation to proceed, an UIC permit is required and typically, an aquifer exemption is needed as well. The exemption effectively removes from the protection of SDWA, an aquifer or portion of an aquifer that would otherwise meet the definition of an underground source of drinking water. The wellfield used by the ISR operation to extract the uranium deposit may constitute only a portion of the overall exempted area. As noted in Section II.E.1 of this proposal, there is no similar exemption for the aquifer from the requirements of UMTRCA, nor does UMTRCA contemplate such a concept. We emphasize again that the SDWA based aquifer exemption does not relieve the operator of an ISR facility of the obligation to remediate environmental contamination resulting from activities regulated under UMTRCA, both within and outside the exempted portion of the aquifer.

2. Alternate concentration limits (ACLs)

Consistent with RCRA, EPA currently allows the use of

ACLs if the operator is unable to restore groundwater to either preoperational background conditions or the applicable maximum constituent concentration. Today we propose to clarify the requirements for requesting and granting ACLs in the production zone, after restoration efforts have taken place. While the 19 criteria to be considered in granting ACLs are spelled out for Title II sites in 40 CFR 192.32(a)(2)(iv) through incorporation of 40 CFR 264.94(b), they have not always been implemented as intended.[60,61] In the past, NRC and Agreement States have issued secondary class-of-use restoration goals at ISR sites,[62] and there is evidence that relaxed restoration standards are routinely granted.[63] In addition, there have been some instances where ACLs have been identified and approved by the regulator before restoration efforts have been initiated and/or completed.[64,65] We believe these situations can result in

[60] These criteria are also reproduced for Title I sites in 40 CFR 192.02(c)(3)(ii).
[61] EPA (1987). "Alternate Concentration Limit Guidance, Interim Final," provides guidance to RCRA facility permit applicants and writers concerning the establishment of RCRA Alternate Concentration Limits. The guidance lists 19 factors, or criteria, that are used to evaluate ACL requests.
[62] "Class of use" designates the potential uses of groundwater based on its quality. For example, groundwater that is not suitable for human consumption may be designated for livestock. Class of use typically encompasses a range of constituent concentration values.
[63] Darling, Bruce (2008). "Report on Findings Related to the Restoration of Groundwater at In-Situ Uranium Mines in South Texas." Southwest Groundwater Consulting, LLC.
[64] Hall, Susan (2009). "Groundwater Restoration at Uranium In-Situ Recovery Mines, South Texas Coastal Plain." U.S. Geological Survey.
[65] Fettus, G. and M.G. McKinzie (2012). "Nuclear Fuel's Dirty Beginnings: Environmental Damage and Public Health Risks from Uranium Mining in the American West." Natural Resources Defense Council.

insufficient protection of groundwater; in particular, we believe it only is appropriate to establish restoration goals based on a thorough characterization of the preoperational environment and not to approve ACLs unless it has proven impracticable to achieve or maintain the initial restoration goals. With this proposal, we specify the conditions that must be met prior to requesting an ACL and emphasize the factors that must be considered in establishing and approving ACLs. These factors specify that, if ACLs are deemed necessary or appropriate, they must not pose a substantial present or potential hazard to human health or the environment.[66]

The regulatory agency may face situations in which the operator will request ACLs. We address the two most common situations in our proposal. First, if after extensive effort the operator determines that the initial restoration goals for one or more constituents cannot be achieved as required in the license, the operator may request and the regulatory

[66] "[A] licensee may propose alternative to specific requirements adopted and enforced by the Commission under this chapter. Such alternative proposals may take into account local or regional conditions, including geology, topography, hydrology and meteorology. The Commission may treat such alternatives as satisfying Commission requirements if the Commission determines that such alternatives will achieve a level of stabilization and containment of the sites concerned, and a *level of protection for public health, safety, and the environment from radiological and nonradiological hazards associated with such sites, which is equivalent to, to the extent practicable, or more stringent than the level which would be achieved by standards and requirements adopted and enforced by the Commission for the same purpose and any final standards promulgated by the Administrator of the Environmental Protection Agency* in accordance with section 2022 of this title." 42 U.S.C. 2114(c), emphasis added.

agency may approve the levels that have been achieved as provisional ACLs and determine that restoration is complete (*i.e.*, that there is no statistically significant trend in the concentrations of regulated species over time). Then, the operator may request and the regulatory agency may approve final ACLs if post-restoration monitoring indicates three consecutive years of stability at the 95 percent confidence level. The approval of final ACLs, however, would not by itself satisfy the requirements for post-restoration stability monitoring.

In the second case, after restoration is complete, the operator may find that post-restoration monitoring detects increases in the concentration of one or more constituents of concern. Depending on the statistical significance of the increase, the regulatory agency may determine that further attempts at restoration or corrective action are needed. If the situation persists after such action is taken, the regulatory agency may choose to wait and see if the increase levels off (*i.e.*, stabilizes). If stabilization does not occur, the operator may request and the regulatory agency may approve final ACLs if post-restoration monitoring indicates three consecutive years of stability at the 95 percent confidence level.

An additional consideration is the potential effect of ACLs on groundwater downgradient of the wellfield. The granting of ACLs could be viewed as inconsistent with the purpose of groundwater restoration, which is to prevent contamination of groundwater resources beyond the production zone. However, NRC has in recent years adopted an approach defining the "point of exposure" as the aquifer exemption boundary, where the initial restoration goal must be met. We propose to adopt a similar approach today.[67] This will ensure that the non-endangerment condition of the UIC permit will be sustained. We request comment on the provisions proposed with respect to granting and complying with ACLs.

We believe the decision to grant an ACL is among the most important that the regulatory agency can make. We believe our proposal appropriately clarifies the situations in which ACLs can be considered and emphasizes the factors that must be considered, thereby making the overall process more rigorous. However, we also recognize that the regulatory agency may need to spend additional effort to evaluate the full record of activities at the site in order to determine whether an ACL is appropriate, and at what level. Because the long-term protectiveness of this decision

[67] EPA guidance on application of ACLs under RCRA makes a similar distinction between the "point of compliance" and the "point of exposure," emphasizing that in granting ACLs, 1) groundwater plumes should not increase in size or concentration above allowable health or environmental exposure levels; 2) increased property holdings should not be used to allow a greater ACL; and 3) ACLs should not be established so as to contaminate off-site groundwater above allowable health or environmental exposure levels. See http://www.epa.gov/wastes/hazard/correctiveaction/resources/guidance/gw/acl.htm.

may not be fully understood until well after site activities conclude and the license is terminated, we encourage the regulatory agency to inform and seek input from the affected public when ACLs are being considered. We believe this request would constitute a license amendment significant enough to warrant an opportunity for public comment, if not public hearings.

C. Adequate characterization of groundwater prior to uranium recovery

To design and operate an ISR facility, the chemical composition and hydrology of the groundwater in and around the ore body must first be rigorously characterized. Defining the configuration of the ore zone and designing the production zone for uranium recovery requires detailed subsurface information obtained from geophysical investigations, including but not limited to logs and cores.[68] In addition, the groundwater in the production zone is also characterized to determine the proposed chemical composition of the lixiviant and to determine background groundwater chemistry by which to set restoration goals for the post-production phase of the ISR operation, *i.e.*, the efforts to return the groundwater chemical conditions in the production zone to those that existed prior to the uranium recovery efforts. The preoperational chemical composition of

[68] EPA (2013). "Considerations Related to Post Closure Monitoring of Uranium In-Situ Leach/In-Situ Recovery Sites."

the groundwater in the production zone is called "baseline" in practice within the ISR industry, and is also used by NRC. In EPA documents and regulations the term "background" is used to indicate the original state of groundwater before activities take place that may introduce contamination into the groundwater, such as leakage of contaminants from a surface or near-surface waste disposal cell or an underground source of contamination such as leaking storage tanks or disposal wells.[69]

For the ISR method, there are a number of "backgrounds" involved, the most important being the preoperational background within the portion of the ore zone where uranium production will take place (*i.e.*, the production zone). Knowledge of this background is necessary to design the leaching process and set restoration goals – two very important steps in the ISR operation. "Background" groundwater composition data are also needed in portions of the aquifer surrounding the wellfield and in overlying and underlying aquifers that may have communication with the uranium ore-bearing aquifer to determine whether excursions occur during operations, and to determine whether seasonal variations in groundwater chemistry are occurring in shallow aquifers. Background data are also needed for geochemical

[69] For example, owners and operators of hazardous waste facilities are required to have a monitoring system that can "represent the quality of background water that has not been affected by leakage from a regulated unit." 40 CFR 264.97(a)(1).

modeling of the groundwater in the production zone and downgradient to support assessments of the long-term stability of the restored wellfield.

There are spatial and temporal designations for the various "backgrounds" measured during the course of an ISR operation. For instance, preoperational background is determined above, around and within the wellfield in the exempted aquifer. The preoperational background downgradient of the wellfield and in aquifers above and below the production zone are needed to detect any excursions that may occur during the ISR operational phase, restoration phase, or post-restoration phase. The uses of the various "backgrounds" are described in the EPA document, "Considerations Related to Post Closure Monitoring of Uranium In-Situ Leach/In-Situ Recovery Sites" (2013).

NRC requires establishment of background at uranium recovery sites in its regulations at 10 CFR 40, Appendix A, Criterion 7;[70] most of the implementing requirements are found in guidance and license conditions. Today's proposal includes provisions to ensure that operators adequately characterize preoperational conditions inside and outside

[70] "At least one full year prior to any major site construction, a preoperational monitoring program must be conducted to provide complete baseline data on a milling site and its environs. Throughout the construction and operating phases of the mill, an operational monitoring program must be conducted to measure or evaluate compliance with applicable standards and regulations; to evaluate performance of control systems and procedures; to evaluate environmental impacts of operation; and to detect potential long-term effects."

the wellfield. This characterization is necessary to establish appropriately protective restoration goals that are representative of the wellfield, accounting for natural variability. There is evidence that regulators and operators have at times used high-end values to represent the overall wellfield or have used a generalized "class-of-use" for the groundwater to set restoration goals.[71] We do not believe this is appropriate, as we explain below.

1. Establishing restoration goals

The successful protection of groundwater at ISR sites begins with the selection of rigorous and appropriate restoration goals. As described in Section III.B of this preamble, restoration goals will be established as the preoperational background concentration or as a specified regulatory level for that constituent, whichever is higher.

This is more complicated than it might seem. ISR wellfields may cover areas of 10 acres or more, and the presence of mineralized zones often means that there is significant variability within the proposed production area. As a result, background concentrations in one area of the wellfield may diverge significantly from those measured elsewhere. The question, then, is whether it is possible to select a single level that is representative of the entire

[71] NRC (2006). "Status of the Development of Memoranda of Understanding with Nebraska and Wyoming Regarding the Regulation of Groundwater Protection at Their In Situ Leach Uranium Recovery Facilities." SECY-05-0123.

wellfield and, if not, how measurements should be evaluated.

We stated previously that we do not believe it is appropriate to select among high-end measurements as representative values for restoration. It might be argued, however, that restoring a given well to its preoperational values would be an indication that restoration would be equally successful in the rest of the wellfield. This might be the case at sites where remediation of groundwater is focused on removing a contaminant that has been introduced from outside the system; however, we question the general application of this assumption at ISR sites, where potentially significant changes in the subsurface through removal of uranium ore and other minerals could result in altered flow patterns, such that "hot spots" may be found at wells that initially registered lower constituent concentration measurements, and vice versa.

Because of the site-specific nature of this variability, we are proposing today that operators utilize background measurements from across the wellfield, combined with appropriate statistical techniques, to determine restoration goals. As appropriate, goals may be developed for individual wells, groups of wells, or the entire wellfield. The point(s) of compliance for restoration will be determined by the operator and regulatory agency after a thorough technical evaluation of the operator's geophysical investigation. We request comment on this approach.

D. Excursions

During the operational and restoration phases at an ISR wellfield, it is possible that the byproduct fluids can escape the capture zones of the extraction wells and move toward the monitoring well ring surrounding the production zone. The placement of the injection and extraction wells, combined with their relative pumping rates, are designed to prevent such movement,[72] but heterogeneities in the aquifer characteristics and difficulties in maintaining perfect performance of the wellfield can lead to lateral excursions as well as excursion into overlying and underlying aquifers. Detecting these excursions is a prime focus of regulatory attention. Indicators of excursions (*e.g.*, increases in concentrations of certain constituents, such as, but not limited to chloride ion, above the preoperational background) are typically defined in the license conditions, as are requirements for reporting excursions to the regulatory authorities and corrective action requirements once an excursion is detected. The excursion monitoring wells are positioned far enough away from the injection and extraction wells so as to not be affected by the production processes, but close enough to detect excursions in a timely manner. The excursion monitoring wells should also be far

[72] EPA (2013). "Considerations Related to Post Closure Monitoring of Uranium In-Situ Leach/In-Situ Recovery Sites."

enough from the aquifer exemption boundary to ensure that any necessary corrective action can be taken before a USDW is adversely impacted. As stated earlier, the placement of the network of wells are approved by the regulatory agency after an extensive technical review of the applicant's geophysical report.

Today we are proposing to adopt a definition of "excursion" consistent with that used by NRC in license conditions. Under this definition, an excursion is identified when two constituents of concern are measured at levels exceeding their upper control limits (essentially, background levels) at perimeter monitoring wells or in monitoring wells in overlying or underlying aquifers. Thus, an excursion can take place vertically between aquifers as well as horizontally within the aquifer being exploited for uranium.

We believe this approach is reasonable and has been shown to be workable in practice. We are also proposing to define "upper control limit" consistent with NRC's use of the term. The "upper control limit parameters" that would signal an excursion will typically be identified in the facility license. We request comment on this approach.

The potential for excursions is also a factor in the facility's decision to stop operations and enter the restoration phase. In some cases, conventional mills may enter a standby period, in which they stop processing ore with the intent to resume operations at some point in the future (the price of uranium is often the decisive factor in these decisions). In some cases, mills have remained on standby for years at a time. For an ISR facility, however, such a "standby" period is impractical because the migration of constituents mobilized by the injection of lixiviant continues even if the decision is made to stop extracting uranium. Excursions beyond the production zone are more likely to occur if the gradient within the wellfield is not maintained. In our view, stopping the extraction cycle must be interpreted as an end to the operational phase and signal the intent to begin restoration. We are interested in stakeholder views on this interpretation.

E. Post-restoration stability monitoring

Perhaps the most significant aspect of today's proposal involves the actions to be taken by the operator after groundwater restoration is complete. If insufficient monitoring is conducted, either in duration, frequency, or in the number of wells used to sample the wellfield, it is very possible to reach premature conclusions of stability. In such cases, residual lixiviant or localized areas within the production zone that have not stabilized may cause continued mobilization of uranium and other constituents after monitoring is terminated, potentially leading to contamination downgradient or beyond the boundary of the exempted aquifer. Today's proposal contains provisions related both to the duration of the monitoring and to the sufficiency of the data necessary to determine that stability has been achieved.

After the ISR operational phase ends, the altered chemical state has to be returned to the preoperational conditions so that uranium and other contaminants do not migrate outside the wellfield. Treatments to re-establish chemically reducing conditions (which greatly reduce the uranium concentration in the ore zone groundwater) can restore groundwater constituents to preoperational background levels to a large extent, although experience has shown that restoration of all constituents to the preoperational background level is seldom 100 percent successful.[73] In addition, the chemically reducing conditions initially present, and the mechanisms that maintained these conditions originally, may not be restored sufficiently to persist over the long-term. Re-oxidation of treated groundwater-host rock systems in other situations has been observed, and post-restoration monitoring at ISR locations has historically been relatively short, typically six months to periods of no more than a few years.[74] A slow

[73] EPA (2013). "Considerations Related to Post Closure Monitoring of Uranium In-Situ Leach/In-Situ Recovery Sites."
[74] EPA (2013). "Considerations Related to Post Closure Monitoring of Uranium In-Situ Leach/In-Situ Recovery Sites."

re-oxidation process with the resulting potential for enhanced migration of uranium may not be detected by a relatively short post-restoration monitoring period. Such an event could occur if the oxidizing agents in the lixiviant significantly removed the reducing agents originally present in the ore zone (*e.g.*, organic material and iron sulfide minerals) that were responsible for sequestering the uranium to form the ore deposit in the first place. Over time oxygenated waters entering the ore zone from up gradient could re-oxidize the uranium removed from solution during the restoration process, mobilizing it once again and transporting it downgradient beyond the wellfield. To determine whether a trend of increased concentrations is occurring, it is necessary to monitor over longer periods and use statistical techniques to analyze the data. This is particularly important if the trend in increased concentrations is relatively slow and the natural variability in the well samples is relatively high.[75] These difficulties point to the need for longer post-restoration monitoring periods than historically performed. However, as discussed earlier, the choice of appropriate statistical techniques to determine the presence or absence of trends in monitoring data can be complicated by shortcomings in the monitoring database, such

[75] EPA (20123). "Considerations Related to Post Closure Monitoring of Uranium In-Situ Leach/In-Situ Recovery Sites."

as missing measurements, "nondetects," analytical errors and other causes that are difficult to avoid in practice for long timeframe monitoring efforts.[76] We have considered several options for the length of the post-restoration monitoring period as described below.

1. Thirty-year post-restoration monitoring period, with provisions for shortening or lengthening that time period

The initial part of our proposal for post-restoration monitoring addresses the duration of monitoring. Specifically, we are proposing that a facility must maintain its post-restoration monitoring for a period of 30 years. In determining the appropriate length of post-restoration monitoring to provide confidence that the restored wellfield conditions will remain stable over time, and considering our statutory direction for consistency with RCRA requirements, we find that some direction can indeed be found in the RCRA regulatory framework. For RCRA hazardous waste disposal facilities, a post-closure monitoring period of thirty years is required before permit termination can occur.[77] Since an engineered RCRA disposal facility for the containment of chemically hazardous waste is similar in concept to relying upon a chemically treated ISR wellfield to contain the potential spread of contaminants, we believe it is

[76] EPA (2013). "Considerations Related to Post Closure Monitoring of Uranium In-Situ Leach/In-Situ Recovery Sites."
[77] See 40 CFR 264.117(a)(1).

reasonable to conclude that a thirty-year post-restoration monitoring period for ISR activities is a consistent application of RCRA requirements. We have examined various statistical techniques for determining the presence or absence of trends in monitoring data, under assumed levels of natural variability and extent of trending, and concluded that, under reasonable values for these variables, a thirty-year monitoring period is adequate to detect relatively slow upward-trending of constituent concentrations.[78]

We recognize that a thirty-year monitoring period would be significantly longer than current practice and that stability may be achieved in a shorter timeframe. Therefore, we are also proposing a provision that would allow the regulatory agency to shorten the monitoring period[79] if the operator can both demonstrate geochemical stability through monitoring and support a conclusion of long-term stability through geochemical modeling. We believe modeling that can provide confidence that a geochemical mechanism exists to prevent uranium and other constituents from re-mobilizing is an important element of any decision to shorten the monitoring period. Further, we believe this provision will

[78] EPA (2013). "Considerations Related to Post Closure Monitoring of Uranium In-Situ Leach/In-Situ Recovery Sites."
[79] This decision authority is also present in RCRA regulations: "… any time during the post-closure period for a particular unit, the Regional Administrator may…shorten the post-closure care period applicable to the hazardous waste management unit…if he finds that the reduced period is sufficient to protect human health and the environment…" 40 CFR 264.117(a)(2).

encourage operators to expend more effort in preoperational site characterization, which will improve their modeling efforts.[80]

We are proposing that three consecutive years of stability be demonstrated through monitoring as a prerequisite before the modeling would be considered as justification for reducing the monitoring period. This provision also has its roots in the RCRA framework, where it is a metric for the success of corrective action after groundwater contamination has been detected.[81] We also see this situation as analogous to the restoration of the ISR wellfield. Stability would be demonstrated statistically at the 95 percent confidence level, which we believe will ensure that operators collect data of sufficient quantity and quality to support regulatory judgments. As noted in Section II.E.2 of this document, a 95 percent confidence

[80] The Agency recently took a similar approach in defining the post-injection monitoring timeframe applicable to Class VI wells used for carbon dioxide geologic sequestration. Owners or operators of Class VI injection wells are required to monitor for at least 50 years after the cessation of injection, unless an alternative timeframe is approved. Further, the monitoring period can be shortened if it can be demonstrated, based on monitoring and other site-specific data, that the project no longer poses an endangerment to USDWs. See 40 CFR 146.93(b).

[81] "If the owner or operator is engaged in a corrective action program at the end of the compliance period specified in paragraph (a) of this section, the compliance period is extended until the owner or operator can demonstrate that the ground-water protection standard of §264.92 has not been exceeded for a period of three consecutive years." 40 CFR 26.96(c) "The owner or operator may terminate corrective action measures taken beyond the period equal to the active life of the waste management area (including the closure period) if he can demonstrate, based on data from the ground-water monitoring program under paragraph (d) of this section, that the ground-water protection standard of §264.92 has not been exceeded for three consecutive years." 40 CFR 264.100(f).

threshold can also be found in the RCRA monitoring program. We request comment on the overall approach of today's proposal.

2. What other options did EPA consider for the post-restoration monitoring period?

In addition to the option described above, EPA considered two other alternatives related to the duration of post-restoration stability monitoring. We are interested in receiving comments and data on all three options described.

a. Required thirty-year post-restoration monitoring period

The second option we considered also relies on the RCRA regulatory framework. In this alternative, no provision for shortening the post-restoration monitoring time frame is permitted, thirty years of monitoring is required. This alternative provides a significant increase in the monitoring period over current industry practice, and the extended time would provide added confidence that the restored wellfield chemistry is remaining stable through this period of time. However, with this option there is still the potential for conditions to change over a longer time period and for contaminant migration to occur. This alternate option does not include any measures to determine groundwater stability, as we are proposing today. However, we anticipate that if upward trending of contaminant concentrations was observed during the monitoring period under either approach, the operator would be required to perform additional corrective action, after which the monitoring period would begin again. We ultimately decided not to pursue this option because it does not sufficiently recognize the site-specific aspects of aquifer restoration or give operators the incentive to reach license termination. We recognize that statistical tests alone, without any associated geochemical modeling, are unable to provide much assurance that groundwater systems will remain in a chemically reduced state over time, although thirty years of consistent statistical performance (*i.e.*, no upward trending) would provide strong support for such a conclusion. We believe it is more reasonable to provide operators with both a performance measure and an opportunity to demonstrate to regulators that stability has been achieved through a means other than statistical analyses of the data collected. We believe the prospect of a thirty-year monitoring period will encourage operators to take advantage of this opportunity.

b. Narrative standard with no fixed monitoring period

We also considered the option of a performance-based standard without explicitly calling for a long-term monitoring period. We considered requiring several conditions be met (*i.e.*, return of both the physical hydrologic system and stability of the geochemical environment) before license termination. To meet the first condition, return of the physical hydrologic system, the groundwater flow regime would have to return to a condition similar to the preoperational flow regime (*i.e.*, no significant residual influences from the injection-extraction restoration cycle) after restoration. Depending on the site, this would likely take many months and perhaps a year or more. To meet the second condition, stability of the geochemical environment, the operator must show that the groundwater chemistry is statistically stable at a 95 percent confidence level for a duration of time sufficient to account for site conditions. These site conditions would include such things as variability of constituents in the wellfield, groundwater velocity, constituent travel times and any seasonal influences. We expect it to take at least several years to collect data sufficient to achieve the 95 percent confidence level. With this approach, the regulatory agency would have maximum flexibility in determining whether to establish general requirements or approach each site on an individual basis.

Ultimately, we decided against this approach for several reasons. As with the previous option, statistical analyses alone would provide no assurance that groundwater systems will remain in a chemically reduced state over a longer time frame than that used for data collection. In addition, this option does not incorporate RCRA's thirty-year post-closure period, which, combined with the modeling requirement in our preferred approach, provides a backstop to the performance measure. Based on these two reasons, we feel that this approach has greater potential for premature termination of the license. Furthermore, ambiguity in the narrative nature of such standards has the potential to provoke litigation and make implementation difficult.

3. How will groundwater stability be determined?

The success of a groundwater restoration effort will be measured ultimately not only on whether the restoration goals are achieved, but also on whether those levels can persist and the geochemistry of the groundwater remain stable in the long term. The intent of the restoration effort is to return the chemical condition of the groundwater in the production zone to the state that existed prior to the initiation of the ISR operations. The persistence in time (*i.e.*, stability) of the chemical condition developed during restoration is the ultimate measure of success for the aquifer restoration effort. We define stability as the state in which the concentrations of the constituents in the groundwater remain relatively constant over time, with no significant trending upward or downward (although the major concern from a regulatory perspective is detecting an upward trend in the concentrations of regulated constituents). The key factor in determining stability, then, is developing a meaningful measure by which to determine whether trending is occurring. Such a measure must address the sufficiency of the data collected, both over time and in its spatial distribution within the wellfield. We discussed the proposed monitoring timeframes in the previous section. The remainder of this section describes how we propose to determine whether groundwater is stable and where we propose to apply this method.

a. What do we propose for determining stability?

There are some similarities between a hazardous waste land disposal situation and an ISR operation that allow us to draw on the RCRA experience for developing standards. Both the RCRA disposal technology and the post-operation aquifer restoration efforts for an ISR operation are intended to prevent contaminants from entering the environment. However, there are some differences that apply to developing ISR standards. An ISR production zone differs from a hazardous waste disposal situation in that the contaminants of concern (largely uranium and radium) were present at significant levels in the groundwater before ISR operations began and will still be present, to some extent, in the groundwater after the aquifer restoration effort has ended; the process will not completely remove them. The concentrations of contaminants of concern are subject to temporal natural variations both before and after ISR operations, and this variability must be taken into consideration in setting standards for judging the adequacy of aquifer restoration. Because of this natural variability, repeated sampling of the post-restoration groundwater must be done to judge the adequacy of the restoration process. To assess when the chemical condition in the wellfield groundwater has become stable, statistical measures and analyses are necessary for examining temporal variations in the water composition data collected over a period of time. Today we are proposing to establish a statistical level of confidence as the standard for determining stability of post-restoration groundwater. We believe this is a relatively simple and straightforward way to represent the level of rigor we believe is necessary to conclude that concentrations of important constituents in the groundwater are not increasing significantly over time.

Determining when groundwater compositions have achieved temporal stability will be a site-specific decision, dependent on the natural variability at the site, which is in turn dependent on many site-specific factors (*e.g.*, temporal and spatial variations in uranium mineral distribution within the aquifer, variations in other chemical constituents that affect uranium dissolution), the frequency of sample collection, and the magnitude of any trends in composition that may be present relative to the magnitude of natural variability. Chapter 7 of the technical background information document supporting this rulemaking discusses these aspects of stability monitoring in much greater detail and illustrates the relationships between sampling frequency and data trends with time.[82] Because of the site-specific interplay between the variables that affect stability, we are not proposing to specify what statistical methods the operator should use to make this determination. There are a variety of methods available that could prove appropriate given the specific conditions at each site. These would include both parametric and non-parametric methods. We recommend that readers consult EPA's "Statistical Analysis of Groundwater Monitoring at RCRA Facilities – Unified Guidance Document" (2009), which provides exhaustive discussion of methods that have been considered for use in the RCRA program. Further discussion of statistical methods for determining trends in groundwater data may also be found in EPA's report, "Considerations Related to Post Closure Monitoring of Uranium In-Situ Leach/In-Situ Recovery Sites" (2013), which was prepared to support this proposal. We emphasize that the choice of statistical method must be

[82] EPA (2013). "Considerations Related to Post Closure Monitoring of Uranium In-Situ Leach/In-Situ Recovery Sites.

based on the quantity and quality of the available data and must be justified accordingly to the implementing regulatory agency.

The intent of the statistical analysis of groundwater monitoring data is to avoid a situation where a wellfield that is unstable is judged to have reached temporal stability, *i.e.*, that the regulatory decision reflect a high degree of confidence in the interpretation of the monitoring data. We are proposing that a statistical confidence level of 95 percent be used to determine stability over time. This level of confidence is often used in regulatory applications, including in the RCRA groundwater monitoring framework.[83] We believe that an equivalent level of confidence, and its implications for sampling and analysis of groundwater composition data, is appropriate for consistency with RCRA approaches and requirements and the statutory direction applicable to this rulemaking. We believe a confidence level of this rigor will make it necessary for operators to collect an appropriate amount of data that clearly demonstrates that the restored ISR aquifer is geochemically stable and that UMTRCA requirements have been met. The frequency of sampling that will provide meaningful data must be determined from site-specific conditions, such as groundwater flow rates. Another consideration is that stability sampling may be misleading

[83] See 40 CFR 264.97.

if the operator has not allowed sufficient time for the natural system to recover to the point where the injection-extraction cycle is no longer influencing groundwater flow parameters in the wellfield and particularly in the immediate area around the monitoring wells.

b. Where will the determination of stability be made?

We have noted that a restored ISR wellfield functions as a RCRA hazardous waste management unit. In this sense, when restoration is completed successfully, and the chemistry of the groundwater has been returned to a reducing environment, the contaminants that were mobilized are essentially "locked in" to the subsurface, as are hazardous constituents that are contained by an engineered unit. Following this reasoning, it might be considered appropriate for the outer boundary of the restored ISR wellfield to be designated as the point of compliance with the groundwater standards. However, we are not taking this approach.

Today we are proposing that each well within the wellfield be considered for use as a point of compliance for purposes of determining stability after restoration is determined to be complete (note that today's proposal does not address the point of compliance for the regulatory agency's determination that restoration is complete, which may be a more complicated matter). We believe that this is appropriate given the size of some wellfields (on the order of hundreds of acres) and the significant variability that is typically present in the mineralized zone. We believe such an approach will more readily inform both the operator and regulatory agency of localized trending, which may then be remedied as appropriate. If the owner/operator is able to demonstrate that a particular well is sufficiently representative of groundwater conditions in a larger area, the regulatory agency may approve the use of one well to demonstrate stability in the area covered by a larger number of wells. We request comment on this approach.

F. Institutional control

Institutional controls are intended to maintain long-term cognizance of the nature and location of particular activities that were done at a specific site, in this case the location of the uranium ore zone exploited by an ISR process. Institutional controls can prevent inadvertent intrusion or adverse consequences for future use of the site. Institutional controls are commonly described as active or passive. Active controls are measures such as guards and fences posted around a site. Passive controls could be the erection of signs or placards at a site.

We are not proposing to establish institutional controls for ISR facilities. Active maintenance of the site will cease with the termination of the license, which will occur when the regulatory agency determines that all license conditions have been met. In this sense, we do not view the post-restoration monitoring period as an institutional control following the ISR restoration phase; rather, we view it as a period of active surveillance to determine the long-term success of the restoration effort.

Nor are we proposing to establish passive controls, either at the site or in documents such as local land records. Requirements for survey plats or other records to be maintained would be consistent with RCRA requirements for hazardous waste facilities; however, these typically apply when waste management units remain at the site and are intended to restrict disturbance of the site.[84] Though we are not proposing that such records be established for ISR sites, we strongly encourage NRC and Agreement States to include such provisions in ISR licenses since our understanding is that ISR sites will not be restricted from sale or further development. Such provisions could simply inform the subsequent owner of the previous ISR and groundwater restoration activities on the property.

G. Other proposed amendments

EPA has identified several non-ISR related provisions within 40 CFR part 192 that should be updated and amended. The issues that we propose to address today include:

- Amending §192.32 to address a ruling of the Tenth

[84] See 40 CFR 264.116 and 264.119.

Circuit Court of Appeals;

- Deleting reference to Grand Junction Remedial Action Criteria (10 CFR 712) at § 192.20(b)(3) since the criteria have been removed from the Code of Federal Regulations (CFR);
- Correcting minor typographical and grammatical errors found in § 192.31 and in § 192.32; and
- Amending the title of 40 CFR 192 to more closely align with the requirements set forth in UMTRCA.

1. Judicial decisions

Section 192.32, has been affected by a ruling from the Tenth Circuit Court of Appeals. Under § 192.32(a)(2)(v), NRC was required to obtain EPA concurrence for approval of ACLs in groundwater restoration. This provision was effectively struck down by the Tenth Circuit Court of Appeals in *Environmental Defense Fund v. U.S. Nuclear Regulatory Commission*, 866 F.2d 1263, 1268-1269 (10th Cir. 1989), when the Court ruled that NRC has authority under AEA section 84(c) to independently make these site-specific ACL determinations, and that NRC has no duty to obtain this EPA concurrence. Therefore, today we are proposing to revise 40 CFR 192.32(a)(2)(v) by deleting the EPA concurrence requirement.

2. Miscellaneous updates and corrections

EPA is proposing an amendment to address an area of part 192 where reference is made to another environmental regulation that has since been removed from the CFR. EPA is also proposing several technical corrections to address known typographical and grammatical errors.

a. Outdated cross-reference

Section 192.20(b)(3) refers to criteria that no longer exist in the CFR. Because of this, EPA is proposing to eliminate reference to the Grand Junction Remedial Action Criteria, which once existed at 10 CFR part 712.

In addition, language in § 192.20(b)(3) cites methods that did not prove effective during the Grand Junction Remedial Action Program.[85] The final report for the program clearly states that filtration (by high efficiency filters or by electrostatic precipitators) and sealants (mainly epoxy-based resins) were not effective over the long term, and were not recommended as remedial options for radon mitigation.[86] EPA plans to eliminate the language referencing sealants and filtration.

b. Technical corrections

Since promulgation of 40 CFR part 192, several typographical and grammatical errors have been identified.

[85] In 1972, Public Law 92-314 created the Grand Junction Remedial Action Program to reduce radiation exposures inside structures affected by uranium tailings. The U.S. Surgeon General published cleanup guidelines for the voluntary project.
[86] Colorado Department of Health (1989). Final Report on the Grand Junction Remedial Action Program.

Today, EPA is proposing amendments in § 192.31(a), § 192.31(f) and § 192.32(a)(2)(v) to address these technical errors (*e.g.*, spelling mistakes, misplaced comma). EPA is also proposing to amend the title of the rule so that it more closely aligns with the requirements set forth in UMTRCA.

V. Summary of Environmental, Cost and Economic Impacts

A. What are the impacts to groundwater?

EPA has conducted a qualitative assessment of the benefits of the proposed rule.[87] The benefits assessment indicates that the proposed rule would result in better designed monitoring programs, reducing the likelihood that groundwater quality in aquifers adjacent to ISR production zones will degrade after closure and license termination of an ISR facility. This, in turn, would lead to reductions in health risks associated with exposure to contaminated groundwater and an increase in the non-health benefits associated with protecting other potential services provided by groundwater.[88]

B. What are the cost impacts?

[87] EPA (2012). "Economic Analysis: Proposed Revisions to the Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings Rule (40 CFR Part 192)."

[88] See National Research Council (1997), "Valuing Ground Water: Economic Concepts and Approaches," which discusses both the extraction value (*e.g.*, value of groundwater used for drinking water, industrial water supply, and agriculture) and the value of in situ services (*e.g.*, buffer against periodic shortages in surface water supplies, protect water quality by maintaining the capacity to dilute and assimilate groundwater contaminants, etc.).

Using information about the uranium extraction industry and estimated incremental costs that would result from the rule as proposed today, EPA examined the economic impacts that may result from the revisions to 40 CFR part 192.[89] [Add language from draft EIA]

VI. Statutory and Executive Orders Review

A. Executive Order 12866: Regulatory Planning and Review and Executive Order 13563: Improving Regulation and Regulatory Review

Under Executive Order 12866 (58 FR 51735, October 4, 1993), this action is a "significant regulatory action." The Executive Order defines "significant regulatory action" as one that is likely to result in a rule that may "raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order."

Accordingly, EPA submitted this action to the Office of Management and Budget (OMB) for review under Executive Orders 12866 and 13563 (76 FR 3821, January 21, 2011) and any changes made in response to OMB recommendations have been documented in the docket for this action.

B. Paperwork Reduction Act

This action does not impose an information collection

[89] EPA (2012). "Economic Analysis: Proposed Revisions to the Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings Rule (40 CFR Part 192)."

burden under the provisions of the Paperwork Reduction Act, 44 U.S.C. 3501 et seq.; no reporting requirements are imposed on affected facilities by this rule. This rule will not in-and-of itself create any new information collection requirements that require approval of the OMB.

Burden means the total time, effort, or financial resources expended by persons to generate, maintain, retain, or disclose or provide information to or for a Federal agency. This includes the time needed to review instructions; develop, acquire, install, and utilize technology and systems for the purposes of collecting, validating, and verifying information, processing and maintaining information, and disclosing and providing information; adjust the existing ways to comply with any previously applicable instructions and requirements; train personnel to be able to respond to a collection of information; search data sources; complete and review the collection of information; and transmit or otherwise disclose the information.

An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The OMB control numbers for EPA's regulations in 40 CFR are listed in 40 CFR part 9.

C. Regulatory Flexibility Act

The Regulatory Flexibility Act (RFA) generally requires an agency to prepare a regulatory flexibility analysis of any rule subject to notice and comment rulemaking requirements under the Administrative Procedure Act or any other statute unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. Small entities include small businesses, small organizations, and small governmental jurisdictions.

For purposes of assessing the impacts of today's rule on small entities, small entity is defined as: (1) a small business whose company has less than 500 employees and is primarily engaged in leaching or beneficiation of uranium, radium or vanadium ores as defined by NAIC code 212291; (2) a small governmental jurisdiction that is a government of a city, county, town, school district or special district with a population of less than 50,000; and (3) a small organization that is any not-for-profit enterprise which is independently owned and operated and is not dominant in its field.

This proposed rule is estimated to impact approximately 25 uranium recovery facilities that are currently operating or may plan to operate in the future. Part 192 currently applies to three existing conventional mills and one proposed conventional mill that is in the process of being licensed. The four conventional mills are: (1) the White Mesa mill in Blanding, Utah, owned by Energy Fuels; (2) the Shootaring Canyon mill in Ticaboo, Utah, owned by Uranium One, Inc.; (3) the Sweetwater mill in Rawlins, Wyoming, owned by Kennecott Uranium Co.; and (4) the proposed Piñon Ridge mill in Montrose County, Colorado, owned by Energy Fuels. Of the four companies that own conventional mills, only one, Energy Fuels, qualifies as a small business under the criteria above.

The proposed revisions to 40 CFR part 192 apply to five currently operating ISRs. The operating ISRs are as follows: (1) Crow Butte (Nebraska) and (2) Smith Ranch (Wyoming), owned by Cameco Resources; (3) Alta Mesa (Texas), owned by Mestena Uranium, LLC; (4) Willow Creek (Wyoming), owned by Uranium One, Inc.; and (5) Hobson (Texas), owned by Uranium Energy Corp. Again, using the criteria above, only Mestena Uranium, LLC and Uranium Energy Corp qualify as small businesses.

In addition to the five operating ISRs, three additional ISRs have been licensed, all in the state of Wyoming. These are: (1) Lost Creek, owned by Ur-Energy Inc.; (2) Moore Ranch, owned by Uranium One, Inc.; and (3) Nichols Ranch, owned by Uranez Uranium Corp. Of these three companies, both Ur-Energy Inc. and Uranez Uranium Corp. qualify as small businesses.

Twelve other ISRs have been proposed for licensing. These include: (1) Dewey-Burdock in South Dakota and (2) Centennial in Colorado, both owned by Powertech Uranium Corp.; in Texas, (3) Benavidas, (4) Kingsville Dome, (5) Los Finados, (6) Rosito, and (7) Vasques, all owned by Uranium Resources Inc.; (8) Crownpoint in New Mexico, owned by Uranium Resources Inc., (9) Church Rock in New Mexico, owned by Strathmore Minerals; (10) Ross in Wyoming, owned by Strata Energy, Inc., (11) Goliad in Texas, owned by Uranium Energy Corp.; and (12) Antelope-Jab in Wyoming, owned by Uranium One, Inc. All of these companies, except for Uranium One, Inc., are small businesses.

Part 192 also applies to heap leach facilities. Although there are no heap leach facilities currently licensed, Energy Fuels has indicated that it may submit a license application for the Sheep Mountain Project in Wyoming.

To evaluate the significance of the economic impacts of the proposed revisions to 40 CFR part 192, [add language from draft EIA]

Of the 20 ISR facilities identified above, 15 are owned by a total of eight small businesses; the other five are owned by two large businesses. No small organizations or small governmental entities have been identified that would be impacted by the proposed revisions to 40 CFR part 192. We continue to be interested in the potential impacts of the proposed rule on small entities and welcome comments on issues related to such impacts.

After considering the economic impacts of this proposed rule on small entities, I certify that this action will not have a significant economic impact on a substantial number of small entities.

D. Unfunded Mandates Reform Act

This rule does not contain a Federal mandate that may result in expenditures of $100 million or more for State, local and Tribal governments, in the aggregate, or the private sector in any one year. The proposed rule imposes no enforceable duties on any State, local or Tribal governments or the private sector. Thus, this rule is not subject to the requirements of sections 202 or 205 of UMRA.

This rule is also not subject to the requirements of section 203 of UMRA because it contains no regulatory requirements or obligations that might significantly or uniquely affect small governments.

E. Executive Order 13132: Federalism

This proposed rule does not have federalism implications. It will not have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government, as specified in Executive Order 13132. None of the facilities subject to this action are owned and operated by State governments, and nothing in the proposed rule will supersede State regulations. Thus, Executive Order 13132 does not apply to this proposed rule.

EPA recognizes that Agreement States will have a substantial interest in this rule revision since they have primary responsibility for implementation of 40 CFR part 192 standards. In the spirit of Executive Order 13132 and consistent with EPA policy to promote communications between EPA and State and local governments, EPA specifically solicits comment on this proposed rule from State and local officials.

F. Executive Order 13175: Consultation and Coordination with Indian Tribal Governments

This action does not have tribal implications, as specified in Executive Order 13175 (65 FR 67249, November 9, 2000). The action imposes requirements on owners and operators of ISR facilities and not tribal governments. Although Executive Order 13175 does not apply to this action, EPA sought opportunities to provide information to tribes and tribal representatives during the review of 40 CFR part 192. EPA specifically solicits additional comment on this proposed action from tribal officials.

G. Executive Order 13045: Protection of Children from

Environmental Health Risks and Safety Risks

EPA interprets EO 13045 (62 FR 19885, April 23, 1997) as applying to those regulatory actions that concern health or safety risks, such that the analysis required under section 5-501 of the Order has the potential to influence the regulation. Because this action addresses environmental standards intended to mitigate health or safety risks, it is subject to Executive Order 13045. We evaluated several regulatory strategies for assuring groundwater restoration and stability at ISR facilities and selected the option providing most assurance that groundwater systems will remain in a chemically reduced state. The protection offered by the proposed standards may be especially important for infants and other populations, including Native Americans.

H. Executive Order 13211: Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution or Use

This action is not a "significant energy action" as defined in Executive Order 13211 (66 FR 28355, May 22, 2001), because it is not likely to have a significant adverse effect on the supply, distribution, or use of energy. This proposed rule will not adversely directly affect productivity, competition, or prices in the energy sector.

I. National Technology Transfer and Advancement Act

Section 12(d) of the National Technology Transfer and Advancement Act of 1995 ("NTTAA"), Public Law No. 104-113, 12(d) (15 U.S.C. 272 note) directs EPA to use voluntary consensus standards in its regulatory activities unless to do so would be inconsistent with applicable law or otherwise impractical. Voluntary consensus standards are technical standards (*e.g.*, materials specifications, test methods, sampling procedures, and business practices) that are developed or adopted by voluntary consensus standards bodies. NTTAA directs EPA to provide Congress, through OMB, explanations when the Agency decides not to use available and applicable voluntary consensus standards.

This proposed rulemaking does not involve technical standards of the type indicated in NTTAA. Therefore, EPA is not considering the use of any voluntary consensus standards.

We request public comment on this aspect of the proposed rulemaking, and specifically, ask you to identify potentially applicable voluntary consensus standards and to explain why such standards could be used in this regulation.

J. Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations

Executive Order 12898 (59 FR 7629, Feb. 16, 1994) establishes federal executive policy on environmental justice. Its main provision directs federal agencies, to the greatest extent practicable and permitted by law, to make environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations in the United States.

EPA has determined that this proposed rule will not have disproportionately high and adverse human health or environmental effects on minority or low-income populations because it increases the level of environmental protection for all affected populations without having any disproportionately high and adverse human health or environmental effects on any population, including any minority or low-income population. This proposed rule addresses groundwater restoration, monitoring and protection of surrounding aquifers and thus decreases the potential groundwater contamination to which all affected populations are exposed.

Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings and Uranium In-Situ Recovery

List of Subjects in 40 CFR Part 192

Environmental protection, hazardous substances, radiation protection, radioactive materials, reclamation, uranium, waste treatment and disposal, water resources

____
Dated:

____
Lisa P. Jackson,
Administrator.

For the reasons stated in the preamble, the Environmental Protection Agency proposes to amend title 40, Chapter I of the Code of Federal Regulations as follows:

PART 192—-[AMENDED]

1. The authority citation for 40 CFR part 192 continues to read as follows:

Authority: Sec. 275 of the Atomic Energy Act of 1954, 42 U.S.C. 2022, as added by the Uranium Mill Tailings Radiation Control Act of 1978, Pub. L. 95-604, as amended.

2. The title for 40 CFR part 192 is amended by the language to read as follows:

PART 192- PUBLIC HEALTH, SAFETY AND ENVIRONMENTAL PROTECTION STANDARDS FOR BYPRODUCT MATERIAL

3. Section 192.20 is amended by revising paragraph (b)(3)as follows:

Subpart C-[Amended]

§192.20 Guidance for implementation.

*   *   *   *   *

(b) * * *

(3) Compliance with § 192.12(b) may be demonstrated by methods that the Department of Energy has approved for use or methods that the implementing agencies determine are adequate. Residual radioactive materials should be removed from buildings exceeding 0.03 WL so that future replacement

buildings will not pose a hazard [unless removal is not practical-see § 192.21(c)]. However, ventilation devices and other radon mitigation methods recommended by EPA may provide reasonable assurance of reductions from 0.03 WL to below 0.02 WL. In unusual cases, indoor radiation may exceed the levels specified in § 192.12(b) due to sources other than residual radioactive materials. Remedial actions are not required in order to comply with the standard when there is reasonable assurance that residual radioactive materials are not the cause of such an excess.

*   *   *   *   *

4. Section 192.31 is amended by:

a. Revising paragraph (a).

b. Revising paragraph (f).

c. Revising the second sentence of paragraph (m).

Subpart D-[Amended]

5. The heading for Subpart D is amended by revising the language to read as follows:

Subpart D – Standards for Management of Uranium Byproduct Materials

*   *   *   *   *

§192.31 Definitions and cross-references.

(a) Unless otherwise indicated in this subpart, all terms shall have the same meaning as in Title II of the

Uranium Mill Tailings Radiation Control Act of 1978, subparts A and B of this part, or parts 190, 260, 261, and 264 of this chapter. For the purposes of this subpart, the terms "waste," "hazardous waste," and related terms, as used in parts 260, 261, and 264 of this chapter, shall apply to byproduct material.

* * * * *

(f) Disposal area means the region within the perimeter of an impoundment or pile containing uranium byproduct materials to which the post-closure requirements of §192.32(b)(1) of this subpart apply.

* * * * *

(m) Available technology * * * This term shall not be construed to include extraordinary measures or techniques that would impose costs that are grossly excessive as measured by practice within the industry or one that is reasonably analogous (such as, by way of illustration only, unreasonable overtime, staffing or transportation requirements, etc., considering normal practice in the industry; laser fusion of soils, etc.), provided there is reasonable progress toward emplacement of a permanent radon barrier.

* * *

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6. Section 192.32 is amended by revising paragraph (a)(2)(v)

as follows:

§192.32 Standards

* * * * *

(a) * * *

(2) * * *

(v) The functions and responsibilities designated in part 264 of this chapter as those of the "Regional Administrator" with respect to "facility permits" shall be carried out by the regulatory agency.

* * * * *

7. 40 CFR part 192 is amended by adding subpart F to read as follows:

Subpart F- Public Health, Safety and Environmental Protection Standards for Byproduct Materials Produced by Uranium In-situ Recovery

Sec.

Subpart F-Public Health, Safety and Environmental Protection

Standards for Byproduct Materials Produced by Uranium In-situ Recovery

§192.50 Applicability.

This subpart applies to the management of uranium byproduct materials prior to, during and following the processing of uranium ores utilizing uranium in-situ recovery methods, and to restoration of groundwater at such sites.

§192.51 Definitions and cross-references.

(a) Unless otherwise indicated in this subpart, all terms shall have the same meaning as in Title II of the Uranium Mill Tailings Radiation Control Act of 1978, subparts A, B, and D of this part, or parts 190, 260, 261, and 264 of this chapter.

(b) <u>Adjacent Aquifer.</u> An aquifer or portion of an aquifer that shares a border or end point with the exempted aquifer or the exempted portion of an aquifer.

(c) <u>Alternate Concentration Limit (ACL).</u> Concentration limit approved by the regulatory agency after best practicable restoration activities have been completed, following the process prescribed in section 192.52(c)(1)(i)(C) of this subpart, for a groundwater constituent that has not been restored to its restoration goal.

(d) Aquifer. A geological "formation," group of formations, or part of a formation that is capable of yielding a significant amount of water to a well or spring. See 40 CFR 144.3.

(e) Background. The condition of groundwater, including the radiological and non-radiological constituents, in the exempted aquifer, adjacent aquifers, and in both overlying and underlying aquifers, prior to the beginning of ISR operations.

(f) Constituent. A detectable component within the groundwater.

(g) Exceedance. An exceedance has occurred when, during post-restoration monitoring, a groundwater protection standard is exceeded at any point of compliance well.

(h) Excursion. The movement of byproduct material fluids from an ISR production zone into surrounding groundwater. An excursion has occurred when, during operations, restoration or stability monitoring, any two upper control limit parameters (*e.g.*, chloride, conductivity, total alkalinity) exceed their respective upper control limits in any overlying, underlying, or perimeter monitoring well. Horizontal excursions refer to the lateral movement of the water, while vertical excursions indicate movement of water through aquitards above or below the exempted aquifer.

(i) Excursion Monitoring Wells. Wells located around the perimeter of the production zone (horizontal excursion wells) and in overlying and underlying aquifers (vertical excursion wells), which are used to detect any excursions from the production zone. Excursion monitoring wells can serve as the "point(s) of compliance" during all phases of ISR.

(j) Exempted Aquifer. An "aquifer," or its portion, that meets the criteria of "underground source of drinking water" in 40 CFR 144.3, but which has been exempted according to the procedures in 40 CFR 144.7. See 40 CFR 144.3.

(k) Extraction Well. Well used to extract uranium enriched solutions from the ore-bearing aquifer; also known as a "Production Well." Extraction and injection wells may be converted from one use to another.

(l) Injection Well. A well into which fluids are being injected. See 40 CFR 144.3.

(m) In-Situ Recovery. A method of extraction by which uranium ores are leached underground by the introduction of a solvent solution, called a lixiviant, through injection wells drilled into the ore body. The process does not require the extraction of ore from the ground. The lixiviant is injected, passes through the ore body, and mobilizes the uranium, and the uranium-bearing solution is pumped to the surface from extraction wells. The pregnant leach solution is processed to extract the uranium.

(n) Lixiviant. A liquid medium used to recover uranium from underground ore bodies. This liquid medium typically contains native groundwater and an added oxidant, such as oxygen and/or hydrogen peroxide, as well as sodium carbonate/bicarbonate or carbon dioxide. The lixiviant is injected through injection wells into the ore body to mobilize the uranium. The resulting solution is then pumped via extraction wells to the surface, where the uranium is recovered from it for further processing.

(o) Maximum Constituent Concentration The maximum permissible level of constituent in groundwater, as specified in 40 CFR 192, Table 1.

(p) Maximum Contaminant Level (MCL). The maximum permissible level of contaminant in water which is delivered to any user of a public water system. See 40 CFR 141.2.

(q) Monitoring Wells. Wells used to obtain water samples for the purpose of determining the amounts, types, and distribution of constituents in the groundwater. Wells are located in the production zone, around the perimeter of the production zone (horizontal excursion monitoring wells), and in overlying and underlying aquifers (vertical excursion monitoring wells).

(r) Operational Phase. The time period during which uranium extraction by in-situ recovery occurs. Operations begin when injection of lixiviant starts; operations end when the operator permanently ceases injection of lixiviant.

(s) Overlying Aquifer. An aquifer that is immediately vertically shallower (*i.e.*, directly above) than the production zone aquifer.

(t) Parameter. A characteristic, feature, or measureable factor that helps to define the groundwater conditions.

(u) Point(s) of Compliance. Site specific location(s) where groundwater protection standards must be met. During all phases of ISR, excursion monitoring wells can serve as the points of compliance; during the restoration, stability and post-restoration phases, points of compliance may also include monitoring, injection and extraction wells in the production zone, as determined by the regulatory agency.

(v) Point(s) of Exposure. Intersection of a vertical plane with the boundary of the exempted aquifer.

(w) Post-Restoration Phase. The period after the groundwater protection standards have been met, as determined by the regulatory agency.

(x) Preoperational Monitoring. Measurement of groundwater conditions in the production zone, and in the groundwater up and down gradient from the production zone, as well as in overlying and underlying aquifers.

(y) Production Zone. The portion of the aquifer in which ISR activities occur. The production zone lies within the wellfield.

(z) Restoration (Act of). The process of returning groundwater quality to preoperational conditions for the purpose of achieving restoration goal values for identified constituents.

(aa) Restoration Goal. A concentration limit for an identified constituent in groundwater after restoration has occurred. Value is derived from the most protective regulatory standards in 40 CFR 141.62, 141.66, 141.80, 143.3, 264.94, and 192, Table 1, and from preoperational background levels in the wellfield, whichever is higher.

(bb) Restoration Phase. The period immediately after uranium extraction ceases, during which restoration activities occur.

(cc) Site. The land or water area where any facility or activity is physically located or conducted, including adjacent land used in connection with the facility or activity. See 40 CFR 144.3.

(dd) Stability Phase. The period after the restoration phase when groundwater protection standards are met and monitored to test for stability.

(ee) Underlying Aquifer. An aquifer that is immediately vertically deeper (*i.e.*, directly below) than the production zone aquifer.

(ff) Upper Control Limit (UCL). Preoperational concentrations of indicator parameters (*e.g.*, chloride, conductivity, total alkalinity) in horizontal and vertical excursion monitoring wells, as determined by the regulatory agency and contained in the license.

(gg) Uranium Recovery Facility. A facility licensed to manage uranium byproduct materials during and following the processing of uranium ores. Common names for these facilities include, but are not limited to, the following: a conventional uranium mill, an in-situ recovery (or leach) facility, and a heap leach facility or pile.

(hh) Wellfield. The area of an ISR operation that encompasses the array of injection, extraction, and monitoring wells, ancillary equipment and interconnected piping employed in the uranium in-situ recovery process. The area of the wellfield exceeds that of the production zone.

§192.52 Standards.

(a) All wellfields shall comply with § 192.52(c) except for those wellfields currently in and remaining in restoration as of the effective date of this rule.

(b) *Surface and subsurface standards.* (1) Surface impoundments associated with ISR activities shall conform to the standards of § 192.32 of this part.

(2) Disposal of solid uranium byproduct materials

produced by ISR activities shall conform to the standards in § 192.32 of this part.

(c) *Groundwater protection standards.* (1) Restoration goals shall be determined for each of the constituents listed in Table 1 to subpart F of this part that is identified in the groundwater. Following restoration activities in the production zone, and prior to license termination, the concentration of a listed constituent in the groundwater within the production zone, as determined by the regulatory agency, must not exceed the higher of the following values:

(i) The background level of that constituent in the groundwater, as determined by preoperational monitoring conducted under § 192.53(b) of this subpart; or

(ii) The lowest concentration listed in 40 CFR 141.61, 141.62, 141.66, 141.80, 143.3, or 264.94 for that constituent.

(2) The regulatory agency may establish provisional alternate concentration limits within the production zone provided that all of the following conditions are met:

(i) All best practicable active restoration activities have been completed in accordance with the permit, but concentrations for a constituent cannot be restored to restoration goals; and

(ii) the constituent concentration will not pose a substantial present or potential hazard to human health or the environment; and

(iii) in all cases, the restoration goals, as determined under paragraph (c)(1) of this section, are satisfied at all points of exposure; and

(iv) the regulatory agency may approve final alternate concentration limits if it determines that the owner/operator has demonstrated groundwater stability at 95 percent confidence for three consecutive years (*i.e.*, no increasing trend in concentration levels as identified by appropriate statistical techniques) of groundwater concentrations for the constituents of concern; and

(v) in deciding whether to approve an alternate concentration limit, the regulatory agency shall consider, at a minimum, the following factors:

(A) Potential adverse effects on groundwater quality, considering:

(1) The physical and chemical characteristics of constituents in the groundwater at the site, including their potential for migration;

(2) The hydrogeological characteristics (*e.g.*, groundwater velocity) of the site and surrounding land;

(3) The quantity of groundwater and the direction of groundwater flow;

(4) The proximity and withdrawal rates of local

groundwater users;

(5) The current and anticipated future uses of groundwater in the region surrounding the site;

(6) The existing quality of groundwater, including other sources of contamination and their cumulative impact on groundwater quality;

(7) The potential for health risks caused by human exposure to constituents;

(8) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to constituents; and

(9) The persistence and permanence of the potential adverse effects.

(B) Potential adverse effects on hydraulically-connected surface-water quality, considering:

(1) The volume and physical and chemical characteristics of the groundwater at the site;

(2) The hydrogeological characteristics of the site and surrounding land;

(3) The quantity and quality of groundwater, and the direction of groundwater flow;

(4) The patterns of rainfall in the region;

(5) The proximity of the site to surface waters;

(6) The current and future uses of surface waters in the region surrounding the site and any water quality

standards established for those surface waters;

(7) The existing quality of hydraulically-connected surface water, including other sources of contamination and their cumulative impact on surface water quality;

(8) The potential for health risks caused by human exposure to constituents;

(9) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to constituents; and

(10) The persistence and permanence of the potential adverse effects.

(C) The presence of any underground source of drinking water as defined under § 144.3 of this chapter and any exempted aquifer identified under § 144.7 of this chapter.

(3) When considering the potential for health risks caused by human exposure to known or suspected carcinogens, alternate concentration limits pursuant to paragraph 192.52(c)(2) should be established at concentration levels which represent an excess lifetime risk, at a point of exposure, to an average individual no greater than between 10^{-4} and 10^{-6}.

TABLE 1 TO SUBPART F – MAXIMUM CONCENTRATION OF CONSTITUENTS FOR GROUNDWATER PROTECTION AT ISR FACILITY SITES	
Constituent	**Maximum Concentration**

Arsenic Barium Cadmium Chromium Lead Mercury Selenium Silver Nitrate (as N) Molybdenum Radium-226 and radium-228 (combined) Uranium (uranium-234, uranium-235 and uranium 238 combined) Gross alpha particle activity (excluding radon and uranium)	The restoration goal is the primary or secondary MCL listed in 40 CFR 141.61, 141.62, 141.66, 141.80, and 143.3, the maximum concentration of hazardous constituents for groundwater protection under 264.94, or the maximum constituent concentration specified in Table 1 to Subpart A of this Part, whichever is most stringent. Where a background concentration is determined to be higher, the background concentration will serve as the restoration goal.

§192.53 Monitoring Programs.

Owners and operators subject to this subpart must conduct a groundwater monitoring program, subject to approval by the regulatory agency, at prospective ISR sites and environs. This program shall address all phases of the site’s activities and must be conducted as follows:

(a) *Preoperational phase monitoring.* (1) A sufficient number of wells, at appropriate locations and depths, shall be installed in such a manner as to yield representative samples in order to define the groundwater flow regime and measure preoperational conditions and water quality for use in statistical tests during licensing, operations, restoration, and post-restoration.

(2) The preoperational background monitoring effort shall include immediately overlying aquifers, immediately

underlying aquifers, and background monitoring inside and outside of the exempted aquifer, particularly in the up and downgradient areas outside of the production zone.

(3) During the monitoring effort, relevant data documenting geology, hydrology and geochemistry for radiological and non-radiological constituents shall be collected, both in the production zone and in surrounding areas that may be affected by the ISR operations.

(i) The monitoring effort shall be of sufficient duration of no less than one year and of sufficient scope to adequately characterize temporal and spatial variations in groundwater, and to account for impacts on background concentrations of constituents and values of parameters due to well installation and development, where applicable.

(ii) Preoperational monitoring shall be focused on determining background concentrations of constituents in point of compliance wells within the proposed production zone, in immediately overlying and immediately underlying aquifers, and outside the production zone, in wells within the exempted aquifer and in upgradient and downgradient wells within non-exempt portions of the adjacent aquifer.

(iii) The owner/operator shall employ appropriate statistical techniques to analyze background concentrations measured in individual wells within the proposed production zone for the purpose of determining restoration goals for groundwater restoration and post-restoration stability monitoring under § 192.52(c)(1) of this subpart. As determined by the owner/operator and approved by the regulatory agency, background concentration limits may be representative of individual wells, multiple wells, or all wells within the proposed production zone.

(iv) Radiological and non-radiological constituents to be monitored during the preoperational phase of an ISR facility shall include:

(A) all constituents listed in Table 1 of this subpart;

(B) constituents and parameters necessary for geochemical calculations of groundwater chemistry in order to demonstrate that a stable groundwater chemistry state, as approved by the regulatory agency, has been achieved through restoration;

(C) all metals potentially mobilized by the recovery process, as determined by the regulatory agency and those necessary for geochemical modeling of site performance; and

(D) any additional constituents or parameters required by the regulatory agency.

(b) *Operational phase monitoring.* (1) Indicator parameters, as established by the regulatory agency, shall be monitored in horizontal and vertical excursion monitoring wells determined by the regulatory agency throughout the operational phase of ISR activities.

(2) If an excursion is detected, as determined by the regulatory agency and as evidenced by indicator parameters exceeding established upper control limits, all constituents listed in Table 1 of this subpart shall be monitored as part of the corrective action program set forth in § 192.54 of this subpart until the excursion is controlled.

(c) *Restoration phase monitoring. (*1) All constituents listed in Table 1 of this subpart or otherwise specified by the regulatory agency shall be monitored during active restoration; sampling should occur no less frequently than quarterly, or other time interval specified by the regulatory agency.

(2) Indicator parameters, as established by the regulatory agency, shall be monitored in horizontal and vertical excursion monitoring wells determined by the regulatory agency throughout the operational phase of ISR activities.

(3) If an excursion is detected, as determined by the regulatory agency and as evidenced by indicator parameters exceeding established upper control limits, all constituents listed in Table 1 of this subpart shall be monitored as part of the corrective action program set forth in § 192.54 of this subpart until the excursion is controlled.

(d) *Stability phase monitoring.* (1) The constituents to be monitored throughout the stability phase of an ISR facility in points of compliance wells in the production zone, as determined by the regulatory agency shall include:

(i) all constituents listed in Table 1 of this subpart;

(ii) any additional constituents required by the regulatory agency, such as:

(A) constituents and parameters necessary for geochemical calculations of the groundwater chemistry in order to demonstrate that a stable groundwater chemistry has been achieved after restoration;

(B) components of the lixiviant fluids injected during uranium recovery and any fluids injected during restoration; or

(C) metals potentially mobilized by the uranium recovery process.

(2) Through field measurements utilizing the monitoring network established to meet the requirements of § 192.53(a) of this section, observations and calculation, and applying appropriate statistical techniques, the owner/operator shall demonstrate that aquifer conditions within the production zone are stable.

(i) Stability shall be demonstrated for three consecutive years at a 95 percent confidence interval and based on sampling no less frequently than quarterly.

(ii) Individual wells within the production zone can be the point of compliance for the purpose of assessing stability, as approved by the regulatory agency.

(iii) If the owner/operator finds that the stability of groundwater meeting the concentration limits determined in § 192.52(c)(1) of this subpart cannot be demonstrated for three consecutive years for one or more constituents, the regulatory agency may:

(A) require the owner/operator to resume active restoration efforts; or

(B) depending on the significance of the departure from the concentration limits determined in § 192.52(c)(1) of this subpart, approve an alternate concentration limit according to the requirements of § 192.52(c)(2) of this subpart.

(3) Indicator parameters, as established by the regulatory agency, shall be monitored in horizontal and vertical excursion monitoring wells determined by the regulatory agency throughout the restoration phase of ISR activities.

(4) If an excursion is detected, as determined by the regulatory agency and as evidenced by indicator parameters exceeding established upper control limits, all constituents listed in Table 1 of this subpart shall be monitored as part of the corrective action program set forth in § 192.54 of this subpart until the excursion is controlled.

(e) *Post-restoration phase monitoring.* (1) Through field measurements utilizing the monitoring network established to meet the requirements of § 192.53(a) of this section, observations and calculation, and applying appropriate statistical techniques, the owner/operator shall demonstrate that post-restoration aquifer conditions within the production zone remain stable and continue to show compliance with groundwater protection standards established under § 192.52(c) of this subpart.

(i) Stability and groundwater protection compliance shall be demonstrated based on sampling no less frequently than quarterly, or other time interval recommended by the regulatory authority.

(ii) Specific, individual wells within the production zone and approved by the regulatory agency shall be the points of compliance for the purpose of assessing stability and groundwater protection compliance, as approved by the regulatory agency.

(iii) Post-restoration monitoring shall be maintained for a period of 30 years. The regulatory agency may shorten the post-restoration monitoring period if, after stability is documented for a period of three consecutive years, the owner/operator demonstrates through geochemical modeling of the site that the subsurface conditions within the production zone will remain stable into the future. In evaluating such modeling, the regulatory agency must determine that there is a reasonable expectation that restoration goals will not be exceeded and that subsurface conditions in the future will not cause the re-mobilization of uranium, radium or other constituents into the groundwater and their migration beyond the boundaries of the production zone.

(2) If one or more monitored groundwater constituents in a point of compliance well within the wellfield exceeds a groundwater protection standard as defined in 192.52(c), or one or more monitored constituents show statistically significant increasing trends that would threaten groundwater quality if left unabated, then the owner/operator must submit a report to the regulatory agency within 60 days describing the circumstances and the corrective actions to be taken. All constituents listed in Table 1 of this subpart shall be monitored as part of the corrective action program set forth in § 192.54 of this part.

§192.54 Corrective action program.

(a) A corrective action program shall be developed and approved by the regulatory agency for each ISR site at the time of licensing. The plan shall address a range of possible excursion scenarios (e.g., minor to catastrophic) and list options for corrective action. If an excursion is detected at a licensed facility at any time during the ISR operational phase, restoration phase, or stability phase, or an exceedance is detected during the post-restoration phase, applicable portions of the corrective action program shall be implemented as soon as is practicable, and in no event later than ninety (90) days after such an occurrence. With the objective of returning constituent concentration levels in groundwater to the concentration levels set as standards (i.e., the restoration goals within the production zone and the maximum contaminant level in adjacent aquifers), the corrective action program shall:

(1) address removing constituents at the point of compliance or treating them in place;

(2) address removing or treating any constituents that exceed concentration limits in groundwater between the point of compliance and the downgradient point of exposure.

(b) The owner/operator shall continue corrective action measures to the extent necessary to achieve and maintain compliance with the groundwater protection standards in § 192.52(c) of this subpart. The regulatory agency, based on data from the groundwater monitoring program and other information that provides reasonable assurance that the groundwater protection standards in § 192.52(c) will not be exceeded, will determine when the owner/operator may terminate corrective action measures.

(c) After the corrective action program has been terminated, the owner/operator must establish and implement a groundwater monitoring program to demonstrate the effectiveness of the corrective action program in stabilizing the concentrations of hazardous constituents in the groundwater. The monitoring program shall continue for a period of not less than 3 years and may be based on the requirements specified in § 192.53.

§192.55 Effective date.

Subpart F shall be effective on [INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION OF FINAL RULE IN FEDERAL REGISTER].